

ForeRunner ASN-9000 Installation and Maintenance Manual

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Software Version ASN_FT 5.0.x

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<u>Caution</u>: Users should not attempt to make such connections themselves, but should contact the appropriate electric inspection authority, or electrician, as appropriate.

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Preface

The intent of this manual is to supply users of the *ForeRunner* ASN-9000 with all the necessary information to successfully install and maintain the ASN-9000. If questions or problems with the installation arise, please contact FORE Systems Technical Support.

Chapter Summaries

- **Chapter 1 Overview -** Provides an overview of the physical characteristics of the ASN-9000. The major functional components and the relationships between them are explained.
- **Chapter 2 Chassis and Packet Engine -** ASN-9000 chassis options and Packet Engine are discussed. How the Packet Engines process traffic through the ASN-9000 is also explained.
- **Chapter 3 Quickstart -** Provides basic quickstart information to assist in getting the ASN-9000 platform installed and operating.
- **Chapter 4 Safety and Environmental Requirements -** Precautions and environmental concerns when handling ASN-9000 components are explained. The hazards and problems that can occur are discussed.
- **Chapter 5 Installation, Upgrade, and Removal Procedures -** This chapter provides procedures to remove and install ASN-9000 components. The procedures include the removal and installation of components while the ASN-9000 is operating.
- **Chapter 6 Boot PROM Commands -** The ASN-9000 supports a series of boot PROM commands. These commands are available to the user in the event the ASN-9000 fails initial loading. The section describes these commands.
- **Chapter 7 ATM Interfaces -** Asynchronous Transfer Mode (ATM) interfaces used in ASN-9000 systems are discussed. The various types of ATM modules and adapters are explained in detail.
- **Acronyms** Lists common networking acronyms and their meanings.
- **Glossary** Contains descriptions of acronyms and terms used in the networking community and throughout this manual.

Related Documentation

The following manuals are referenced throughout this manual. These manuals, including this manual, comprise the *ForeRunner* ASN-9000 Reference Manual set.

- ForeRunner ATM Services Node 9000 (ASN-9000) Release Notes, MANU0274-03, June 1, 1998
- ForeRunner ASN-9000 Software Reference Manual, MANU0272-02, June 1, 1998
- ForeRunner ASN-9000 Filters Reference Manual, MANU0280-02, June 1, 1998
- ForeRunner ASN-9000 Protocols Reference Manual, MANU273-02, June 1, 1998

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http://www.fore.com/

2. Send questions, via e-mail, to:

support@fore.com

3. Telephone questions to "support" at:

800-671-FORE (3673) or 724-742-6999

4. FAX questions to "support" at:

724-742-7900

Technical support for customers outside the United States should be handled through the local distributor or via telephone at the following number:

+1 724-742-6999

No matter which method is used to reach FORE Support, customers should be ready to provide the following:

- A support contract ID number
- The serial number of each product in question
- All relevant information describing the problem or question.

Typographical Styles

Throughout this manual, specific commands to be entered by the user appear on a separate line in bold typeface. In addition, use of the Enter or Return key is represented as <ENTER>. The following example demonstrates this convention:

cd /usr <ENTER>

Commands or file names that appear within the text of this manual are represented in the following style: "...the fore_install program installs this distribution"

Important Information Indicators

To call your attention to safety and otherwise important information that must be reviewed to insure correct and complete installation, as well as to avoid damage your system, FORE Systems utilizes the following *WARNING/CAUTION/NOTE* indicators.

WARNING statements contain information that is critical to the safety of the operator and/or the system. Do not proceed beyond a WARNING statement until the indicated conditions are fully understood or met. This information could prevent serious damage to the operator, the system, or currently loaded software, and will be indicated as:

WARNING!



Hazardous voltages are present. To lessen the risk of electrical shock and danger to personal health, follow the instructions carefully.

Information contained in CAUTION statements is important for proper installation/operation. CAUTION statements can prevent possible equipment damage and/or loss of data and will be indicated as:

CAUTION



You risk damaging your equipment and/or software if you do not follow these instructions.

Information contained in NOTE statements has been found important enough to be called to the special attention of the operator and will be set off from the text as follows:



Steps 1, 3, and 5 are similar to the installation for the computer type above. Review the previous installation procedure before installation in your particular model.

Laser Warning

Class 1 Laser Product: This product conforms to applicable requirements of 21 CFR 1040 at the date of manufacture.

Class 1 lasers are defined as products which do not permit human access to laser radiation in excess of the accessible limits for Class 1 for applicable wavelengths and durations. These lasers are safe under reasonably foreseeable conditions of operation.

The ASN-9000 ATM single-mode physical layer ATM Media Modules (AMAs) contain Class 1 lasers.

Safety Agency Compliance

This preface provides safety precautions to follow when installing a FORE Systems, Inc., product.

Safety Precautions

For your protection, observe the following safety precautions when setting up your equipment:

- Follow all warnings and instructions marked on the equipment.
- Ensure that the voltage and frequency of your power source matches the voltage and frequency inscribed on the equipment's electrical rating label.
- Never push objects of any kind through openings in the equipment. Dangerous voltages may be present. Conductive foreign objects could produce a short circuit that could cause fire, electric shock, or damage to your equipment.

Symbols

The following symbols appear in this book.

WARNING!



Hazardous voltages are present. If the instructions are not heeded, there is a risk of electrical shock and danger to personal health.

CAUTION



If instructions are not followed, there is a risk of damage to the equipment.

Modifications to Equipment

Do not make mechanical or electrical modifications to the equipment. FORE Systems, Inc., is not responsible for regulatory compliance of a modified FORE product.

Placement of a FORE Systems Product

CAUTION



To ensure reliable operation of your FORE Systems product and to protect it from overheating, openings in the equipment must not be blocked or covered. A FORE Systems product should never be placed near a radiator or heat register.

Power Cord Connection

WARNING!



FORE Systems products are designed to work with single-phase power systems having a grounded neutral conductor. To reduce the risk of electrical shock, do not plug FORE Systems products into any other type of power system. Contact your facilities manager or a qualified electrician if you are not sure what type of power is supplied to your building.

WARNING!



Your FORE Systems product is shipped with a grounding type (3-wire) power cord. To reduce the risk of electric shock, always plug the cord into a grounded power outlet.

Command Syntax

The following expressions are used in this manual when describing command syntax:

AaBbCcDd A term that is being defined. Example:

IP Helper is an enhancement to the **ip** subsystem that allows a system to be boot from a server separated from the boot client by a gateway.

AaBbCcDd

A command name. ASN-9000 commands are casesensitive; they should always be issued in lowercase. Example:

dir

- 1) Separates the full and terse forms of a command or argument:
- The full form is shown on the left of the |.
- The terse form is shown on the right of the |.

Example:

dir | ls

When the command or argument is entered, either the full form or terse form may be used. In this example, either **dir** or **ls** can be used.

2) Separates mutually exclusive command arguments. Example:

active-ama|aa cset p[rimary]|b[ackup] <slot>|all

In this example, the command **active-ama** | **aa** can accept either **active-ama** or **aa**, but not both.

[] Enclose optional command arguments or options. Example:

active-ama|aa [show] [linemode|lm] <slot>|all

In this example, the [] enclose optional arguments. The command can be issued without the argument(s) shown in []. However, the argument must be one of the two options listed between the [].

<AaBbCcDd>

Indicates a parameter for which a value is supplied by the operator. When used in command syntax, <*italics*> indicates the value to be supplied. Example:

savecfg <filename>

In this example, *<filename>* is a parameter for which a value must be supplied with the command when issued.

AaBbCcDd

Indicates a field or file name.

An example of a field name is when booting the software, the login: prompt is displayed.

A file name example is when booting the software, the system looks for a file name cfg.

Indicates text displayed by the software or input typed at the command prompt. To distinguish typed input from command output, the typed input is shown in bold typeface. Example:

AaBbCcDd or AaBbCcDd

22:ASN-9000:system# bootinfo
Thu Aug 7 13:03:38 1997 start
Thu Aug 7 13:03:43 1997 nvram boot order: m
boot device: m

In this example, the user enters **bootinfo** and the software responds with

Thu Aug 7 13:03:38 1997 start
Thu Aug 7 13:03:43 1997 nvram boot order: m
boot device: m.

Preface

CHAPTER 1

Overview

This chapter provides an overview of the physical characteristics of the *ForeRunner* ASN-9000, including the use of the terms "slot," "port," and "segment" as they apply to the ASN-9000. The configuration and management features supported by the ASN-9000 system is also introduced. Figure 1.1 shows a 5-slot ASN-9000. This chapter provides information on the following subjects:

- ASN-9000 Chassis
- Chassis Features
- · Intelligent Packet Switching
- · Chassis Configuration
- Software Features

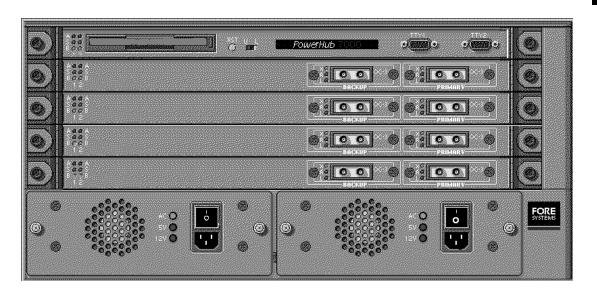


Figure 1.1 - ForeRunner ASN-9000

1.1 ASN-9000 Chassis

The ASN-9000 is available in a 5-slot chassis and is configurable with power modules and ATM PowerCell Modules. The following sections describe the different chassis configurations. The ASN-9000 is available in a 5-slot chassis, can contain up to two power modules and contains a two-channel backplane. The heart of the ASN-9000 is the Packet Engine (PE). The PE supports the two packet-channel backplane in the 5-slot chassis. The two-channel backplane supports 800Mb/s bandwidth per channel, providing a total throughput of up to 1.6 Gbp/s. For more information on the Packet-Channel Backplane, refer to Section 1.3.1. For more information on the PE, refer to Section 1.3.2.

1.2 Chassis Features

The ASN-9000 chassis contains card slots in which the packet engine and ATM PowerCell Modules can be inserted to provide various physical network interfaces. Security features are provided to help protect the ASN-9000 from unwanted access and tampering. The sections below provide information on the following:

- How ports, slots, and segments are defined and numbered
- Modules (NIMS and media adapters)
- Security

1.2.1 Ports, Slots, and Segments

The term "segment" refers to a single ATM virtual connection. For example, each physical network connection on a NIM connects to an individual segment. The term segment also applies when a segment is operating in full-duplex mode.

The word "port" is also used to refer to the TTY (TTY1/TTY2) ports on the Packet Engine. However, these ports are clearly distinguishable from micro-segmented ports.

Virtual segments are created on the PowerCell ATM modules. Virtual segments are created when multiple ATM segments are assigned to a single ATM port. The PowerCell 700 ATM module can support up to 32 virtual segments on a single ATM port. Note that if a second port exists on the PowerCell module, it is a redundant port for failover use only and does not support additional segments or load/connection balancing.

Connections on a PowerCell 700 ATM Module are for one physical (PHY) port with up to 32 logical segments.

1.2.2 Card Slots and Segments

The card slots accommodate Network Interface Modules (NIMs). The number of slots in the chassis varies with the size chassis installed. Each slot in the chassis accommodates one module. Segments are numbered according to the following rules:

- Segments are counted from the bottom slot up. Counting of segments begins with the first segment encountered by the software. Within a slot, segments are numbered from left to right. The ASN-9000 supports 96 segments.
- The chassis can be populated with NIMs that total more than the maximum number of supported segments. However, only the supported number of segments are recognized.
- The last supported segment can be in the "middle" of a module. A segment boundary need not occur on the last segment of a module.
- Filled and blank NIM slots may be combined in any form, but only installed segments are numbered. In other words, NIMs with 0 segments can be installed between slots with more than 0 segments.

The allocation of segments on each module can be changed with the nvram slotsegs[n] set command. Refer to the *ForeRunner ASN-9000 Software Reference Manual* for detailed information on the nvram subsystem commands.

1.2.3 Security Features

The ASN-9000 contains both hardware and software levels of security. At the software level, filters for bridge, TCP, IP, IP RIP, AppleTalk, and IPX RIP and SAP packets can be created. Refer to the *ForeRunner ASN-9000 Filters Reference Manual* for more information on applying filters. The following paragraphs describe the hardware level security features.

1.2.3.1 ASN-9000 Hardware Security

The ASN-9000 has two levels of hardware security. A Lock/Unlock switch, located on the PE1 front panel, and Lock/Unlock jumpers, located on the PE1 circuit board. When the Lock Switch is set to lock (L), a user must enter a valid login ID and password to execute commands that affect configuration settings. The position of the Lock/Unlock jumper setting overrides the front panel switch setting. Refer to *Chapter 2, Chassis and Packet Engine* for more information on the Lock/Unlock Switch and *Chapter 5, Installation, Upgrade, and Removal Procedures* for instructions on changing the Lock/Unlock Jumper.

1.2.4 Displaying Chassis Configuration and Segment Numbers

Segment numbers can be displayed through the user interface (UI) by issuing the config command from the system subsystem (refer to the ForeRunner ASN-9000 Software Reference Manual for information on system subsystem commands). This command displays basic chassis configuration information, including:

- The amount of installed DRAM (in megabytes).
- Baud rates for the TTY ports (TTY1/TTY2).
- Slot containing the Packet Engine (PE)
- Presence and status of power modules (PMs).
- Number of segments present in each slot, and the medium type in use by each segment.

1.3 Intelligent Packet Switching

The ASN-9000 utilizes the Packet Engine to process packets traveling on configured segments. The Packet Engine is a centralized packet-processing and forwarding engine. When a packet is received on a segment, the packet is forwarded to the Packet Engine and placed in Shared Memory where it is examined and either dropped or forwarded as applicable.



Segments are attached through NIMs. Under certain circumstances Intelligent Network Interface Modules (INIMs) can perform some packet processing that bypass the Packet Engine and enhance packet throughput. Refer to Section 1.4.2.1 for more information on INIMs.

1.3.1 Packet-Channel Backplane

The Packet-Channel Backplane contains a two-channel backplane in the ASN-9000. Each channel of the backplane can handle data throughput up to 800Mb/s. The packet channels connect all installed interface modules directly with the packet engine. Refer to *Chapter 2, Chassis and Packet Engine* for detailed information on the Packet Channel Backplane.

1.3.2 Packet Engine (PE)

The Packet Engine (PE) was the first-generation packet engine. The PE contains 2 CPUs that accesses the two-channel packet-channel backplane found in the ASN-9000. Refer to *Chapter 2, Chassis and Packet Engine* for detailed information on the PE.

1.4 Chassis Configuration

The ASN-9000 chassis is designed for easy re-configuration in response to networking needs. Upgrades can be performed using a few standard tools (usually ordinary screwdrivers). Network downtime is minimal while performing the upgrades.

The chassis is configured by adding NIMs, power modules, and various other performance-enhancing options. NIMs provide the interfaces to the ASN-9000. The NIMs are connected to the PE by the Packet Channel Backplane. Packets and control data sent between the PE and NIMs pass through this backplane. Power modules provide load sharing and redundancy.

1.4.1 PE Performance Enhancing Options

Performance of the ASN-9000 can be enhanced in several ways. These enhancements can increase the packet-processing speed of the PE, increase protocol support, and add redundancy to the system in case of component failure. Depending upon network needs, one or more of the performance-enhancing options described below can be added *Chapter 5, Installation, Upgrade, and Removal Procedures* contains complete instructions for adding these hardware options.

1.4.1.1 Packet Accelerator Upgrade

Adding a Packet Accelerator to the PE increases the packets-per-second throughput by adding RISC CPUs to increase the processing power of the PE. Refer to *Chapter 5, Installation, Upgrade, and Removal Procedures* for instructions for Packet Accelerator Installation.

1.4.1.2 Flash Memory Module Upgrade

The Flash Memory Module is very useful for fast system booting. It allows storing and local file management on the PE. Refer to *Chapter 5, Installation, Upgrade, and Removal Procedures* for instructions for Flash Memory Module Upgrade.

1.4.2 Network Interface Modules

As connectivity needs change, interfaces can be added or changed by adding or changing ATM PowerCell modules. ATM PowerCell modules can be removed, swapped, and rearranged in the chassis.



Ports are not the same as segments. Refer to Section 1.2.1 for information about how the terms "port" and "segment" are used in the ASN-9000.

Each NIM contains physical connectors and on-board electronics to support ATM protocols. The ASN-9000 supports up to a total of 96 independent segments.

The ASN-9000 can be configured with up to 32 logical ATM segments as long as the number does not exceed the total number of supported segments. The system is designed to balance configuration flexibility and packet throughput. NIMs can be installed in any position in the chassis except the slot(s) reserved for the Packet Engine. (Refer to *Appendix B, Balancing Bandwidth* for detailed information on optimizing performance.)

The following section provides an overview of the ATM PowerCell. ATM PowerCells can be added, removed, or reconfigured in the chassis when necessary.

1.4.2.1 PowerCell 700 ATM Modules

The PowerCell 700 ATM module contains the ATM physical layer (PHY) and ATM Segmentation and Reassembly (SAR) layers.

The PowerCell 700 module can be installed in any slot except the slot(s) reserved for the Packet Engine. Up to four PowerCell 700 modules can be installed in an ASN-9000 chassis. Each PowerCell 700 can support up to 32 logical segments.

The PowerCell module contains the following hardware features:

- AAL5 support.
- Support for up to 155 Mb/s.
- Traffic and status LEDs.
- Optional Backup PHY (redundant) connection.
- Choice of DS-3, E-3, or UTP interfaces.
- Choice of single-mode or multimode fiber on the OC-3 interface.

Connections to the ATM network is made by attaching the PowerCell module to an ATM switch, which in turn is connected to the ATM network. The PowerCell module is interoperable with all FORE Systems' ATM switches. The PowerCell module can also be used with other

vendors' ATM switches provided those switches conform to the ATM Forum standards that the PowerCell module supports. For example, other vendors' equipment must support the ATM Forum standards for LAN Emulation (LANE) version 1.0 and 2.0 and User-Network Interface (UNI) 3.0 or 3.1 if this equipment is to be used with the FORE Systems PowerCell module in a LANE 1.0 or 2.0 network.

1.4.3 Power Sharing and Redundant Power Modules

The *ForeRunner* ASN-9000 supports load sharing and redundant power to ensure uninterrupted operation in the event that a power module fails. The ASN-9000 can be equipped with up to four power modules. The load is shared across the functioning power modules and redistributed if a power module fails. These two features increase the life span of the power modules and reduce the likelihood of power module failure.

Power modules are available in two AC versions (283 Watt and 500 Watt) and a 48-volt DC version. When redundant power modules are installed, NIMs can be "hot swapped," allowing configuration changes while the system is operating. The 500 Watt power modules are for use in the 10- and 15-slot chassis. Refer to *Chapter 2, Chassis and Packet Engine* for more information on power modules.

1.4.4 Status LEDs

Packet Engine or intelligent NIM status information, as well as traffic information and connection status is displayed in LEDs located on each module.

Status LEDs indicate whether the module has experienced a failure, is performing normal runtime tasks, or is loading software. A "sticky" Alarm LED (the Packet Engine status LED remains lit) indicates that a crash has occurred. Refer to *Chapter 2, Chassis and Packet Engine* for further information on the PE status LEDs.

1.5 Software Features

ASN-9000 software features are documented in the *ForeRunner ASN-9000 Software Reference Manual, ForeRunner ASN-9000 Protocols Software Reference Manual* and the *ForeRunner ASN-9000 Filters Reference Manual*. The following are short descriptions of some features with references to manuals that contain more complete information.

1.5.1 DOS-Like File Management System

The Floppy Disk and Flash Memory Module use a DOS-like file management system. Files created or stored on these devices can be edited using a standard ASCII editor on another device (PC, Macintosh, etc.). Note that the file management system does not support hierarchical directory structures.

1.5.2 Concurrent Command-Line Sessions

Concurrent command line sessions are supported. The primary command-line session is always established through a direct connection between a PC or modem and the RS-232 port labeled TTY1 on the packet engine. A second TTY port (TTY2) can be used to establish a second direct connection.

Additionally, up to two in-band TELNET sessions can be established with the command-line interface. To use TELNET, an IP interface is defined on the segment attaching the ASN-9000 to the terminal. For more information on command-line sessions, refer to *Chapter 3, Quickstart*.

1.5.3 Multiple Boot Sources

The ASN-9000 software can be loaded entirely from a floppy disk or Flash Memory Module. A combination of boot sources can be configured and saved in a bootdef file. After booting, the ASN-9000 can be configured using configuration and environment files.

If possible, configure the ASN-9000 to attempt loading from both sources in any order. If one method fails, the ASN-9000 attempts to load using the remaining method.

1.5.3.1 Configuration and Environment Files

When configuring the ASN-9000, parameters such as the name, routing interface definitions, and filters, can be defined. These definitions are not retained across power cycles. They can, however, be saved and re-instated at any time using the appropriate software commands.

The system savecfg command creates a file called cfg and saves it on the default-device (floppy disk (fd:) or Flash Memory Module (fm:)). This file contains ordinary commands, such as might be issued to configure the system. When booting, this cfg file is read, com-

mands executed, and the system is configured according to its contents. Multiple configurations can be created and loaded as needed. It is recommended that the old configuration file is saved as a back-up before replacing it with the new configuration file.

Parameters for command-line sessions can also be stored and read into the ASN-9000. Session parameters are stored in environment files (*.env). Like configuration files, environment files contain ASN-9000 commands and can be loaded during login. Unlike configuration files, environment files apply only to the command-line session in which they are loaded.

1.5.4 Easily Accessible Dump Files

The ASN-9000 is designed for reliable operation under diverse traffic demands. However, in the event the system crashes, an attempt is made to reboot the system. A dump file is written to the default-device. This dump file is named fore.dmp and contains information that can be used by FORE Systems TAC to help diagnose the cause of the crash.

FORE Systems TAC can also use the contents of the dispcfg file to diagnose system problems. The dispcfg file is a configuration file provided with the system software diskettes. When reading the file (by issuing the system readcfg dispcfg), the software configuration of the system is displayed on the management terminal.

1.5.5 On-Line Hardware Information

At any time during normal operation, commands can be issued to display various hardware information, including the following:

- · Chassis configuration
- Power module status
- · Module identification and power requirements
- Current temperature of installed modules
- Segment state, status, and statistics
- Presence of a Packet Accelerator

Hardware information is displayed using commands in the system subsystem. Information about the segment state, segment status and segment statistics, as well as BNC termination states are available through commands in the media subsystem. For detailed information about the system and media subsystem commands, refer to the ForeRunner ASN-9000 Software Reference Manual.

1.5.5.1 Packet Statistics

Packet statistics for any group or range of segments or ports can be displayed. For example, the number of packets received by a particular segment since the system was last booted can be displayed. For most statistics, two separate counters are maintained. For information on displaying statistics for a specific protocol, refer to the *ForeRunner ASN-9000 Protocol Reference Manual* section on the respective protocol type.

Statistical tracking begins when the ASN-9000 is booted and continues until it is powered down or re-booted. This counter always shows the count accumulated since the system was last reset.

Statistical counters can be cleared at any time. When displaying the contents of this counter, the count displayed is the count subsequent to the last time the counter was cleared.

1.5.6 Bridging and Multi-Protocol Routing

Segments can be configured to bridge (as specified in IEEE 802.1d) as well as route packets according to any combination of the following standard protocols:

- IP
- IPX
- AppleTalk
- DECnet

The ASN-9000 contains an implementation of IP Multicast, which allows multicast routing for bandwidth-intensive applications, such as video conferencing. The same segments can be used to bridge and route packets. In fact, a segment can be configured to not only bridge, but route all four protocols, and perform IP Multicast. For information on configuring segments for bridging and routing, refer to the *ForeRunner ASN-9000 Protocols Software Reference*.

1.5.7 Virtual LANs (VLANs)

To make management of network segments easier, the ASN-9000 allows creation of Virtual LANs (VLANs). A VLAN is a network that spans two or more physical segments. VLANs make network configuration changes by allowing the creation and changing of LANs logically, as opposed to physically moving segment cables. The ASN-9000 bridges, rather than routes, packets among segments in a VLAN. Figure 1.2 shows an example of a typical VLAN.

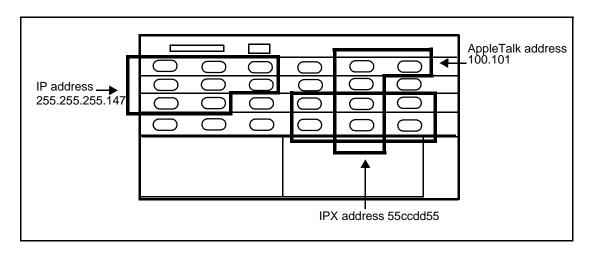


Figure 1.2 - Virtual LAN Examples

As shown in Figure 1.2, a VLAN consists of a group of segments. Each segment in the VLAN has the same interface address. VLANs for IP, IPX, and AppleTalk interfaces can be created. Notice that VLANs can overlap. Refer to the *ForeRunner ASN-9000 Protocols Reference Manual* for more information on VLAN configuration.

1.5.8 Security Filters

In addition to the Lock Switch and password protection described in Section 1.2.3, logical filters can be defined to control traffic entering and leaving the ASN-9000, or specific segments or interface addresses. Filters can be defined on the following protocols:

- AppleTalk
- Bridge
- TCP and UDP
- IP
- RIP
- · IPX RIP and SAP

The ASN-9000 also contains an implementation of IP security as defined in RFC 1108. For detailed information on filters, refer to the *ForeRunner ASN-9000 Filters Reference Manual*.

1.5.9 SNMP and MIB Support

ASN-9000 commands can be used to define Simple Network Management Protocol (SNMP) managers and communities. Once the system is configured so that it can be managed through SNMP, implementations of the following standard Management Information Bases (MIBs) can be accessed:

- MIB II (RFC 1213)
- AppleTalk MIB (RFC 1243)
- Bridge MIB (RFC 1286)
- OSPF V2 MIB (RFC 1253)
- Mini-RMON MIB (RFC 1757)

In addition, SNMP can be used to access objects in the ASN-9000 MIB, which is designated as enterprise MIB 390. The ASN-9000 MIB contains objects not contained in the standard MIBs listed above, as well as objects that display configuration information. This includes objects for displaying the current software installed and various configuration information. Refer to the *ForeRunner ASN-9000 Software Reference Manual* for information about configuring SNMP and the standard and ASN-9000 MIB objects.

Overview

Overview

CHAPTER 2

Chassis and Packet Engine

The ASN-9000 is designed to grow with network needs. The ASN-9000 contains a modular chassis and is available in a 5-slot chassis with a two-channel backplane and two Power Module bays. .

The ASN-9000 makes use of a Packet Engine to intelligently process and forward packets. This chapter describes the following hardware:

- Chassis (See Section 2.1)
- Packet Channel Backplane (See Section 2.2)
- Packet Engine (See Section 2.3)
- Power Modules (See Section 2.4)
- Fan Module (See Section 2.5)

2.1 Chassis

The ASN-9000 (shown in Figure 2.1) incorporates a modular chassis design. Most components can be added or removed at any time. The following sections provide additional information on chassis options. The ASN-9000 contains slots, or bays, which accommodate the following modules:

- One Packet Engine (PE)
- Up to 4 ATM PowerCells
- One fan module
- Up to two power modules

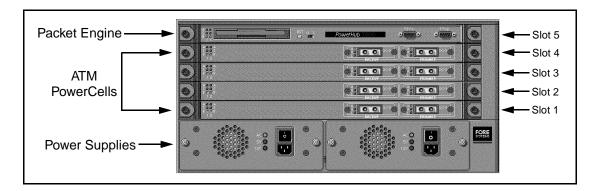


Figure 2.1 - ASN-9000 Chassis

2.1.1 Packet Engine Placement

The Packet Engine 1 (PE1) in the ASN-9000 always occupies the top slot of the chassis.

2.1.2 NIM Placement

All other slots accommodate ATM PowerCells, configurable modules that provide connections to network segments. Refer to *Chapter 1, Overview* for information on ATM PowerCells.

The bottom of the chassis contains the power module bays. Not shown are the Packet Channel Backplane and the Fan Module. See Section 2.2 for information on the Packet Channel Backplane and Section 2.5 for information on the Fan Module.

2.2 Packet Channel Backplane

The Packet Channel Backplane is the hardware connection between the Packet Engine and any installed ATM PowerCells. The Packet Channel Backplane enables packets and control data to be passed to and from the Packet Engine when processing is required.

The Packet-Channel Backplane carries traffic at 800 Mb/s (32 bits @ 25 MHz) per channel.

2.2.1 BUS Control Module

The Bus Control Module (BCM) contains clock distribution and bus termination circuits for the Packet Channels. It provides the physical interface to allow the Packet Channels to interface with the Packet Engine. The ASN-9000 is shipped with the correct BCM attached, so no maintenance is required.

2.2.2 ForeRunner ASN-9000

The ASN-9000 is available in a 5-slot chassis. Slots are numbered from 1 through 5, bottom to top. The PE is installed in the uppermost slot. Network Interface Modules (NIMs) can be installed in any of the other available slots. Figure 2.2 illustrates the relationship between the Packet Channel Backplane, Shared Memory, and the NIMs in a 5--slot ASN-9000.

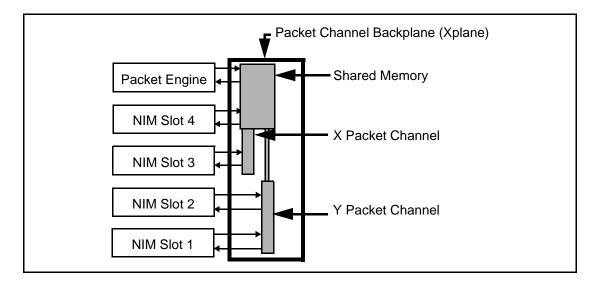


Figure 2.2 - ASN-9000 Packet Channel Backplane

• The Packet Channel Backplane joins the slots in the chassis together, carrying information between the PE and installed NIMs using the Packet Channels. As shown in Figure 2.2, slots 1 and 2 are served by the Y Packet Channel and 3 and 4 by the X Packet Channel.

Information is exchanged between the Packet Engine and NIMs across the Packet Channels at speeds up to 800~Mb/s per channel (32 bits at 25 MHz) for a total of 1.6 Gbps, fast enough to support non-blocking operation of a fully-loaded system.

2.3 Packet Engine

Each ASN-9000 requires a Packet Engine, the centralized packet processing and forwarding engine. The Packet Engine is installed in a specific slot in the chassis. The slot in which the Packet Engine is installed is dependent on the type of backplane and chassis size.

The Packet Engine examines packet headers for bridging and routing then modifies them as required for routing. When a segment connector receives a packet, the connector transfers the packet directly to Shared Memory on the Packet Engine. Bridging and routing engines in the Packet Engine store all packets and related data structures in Shared Memory. This contributes to high packet throughput because all packet-related data is stored in one place.

The Packet Engine contains the following components (all items listed are common unless otherwise stated):

- Status LEDs (See Section 2.3.1.1)
- Floppy drive (See Section 2.3.1.2)
- Reset switch (See Section 2.3.2)
- Lock switch (See Section 2.3.3)
- RS-232 ports (See Section 2.3.3.1)
- Flash Memory module (See Section 2.3.1.3)
- Temperature sensor (See Section 2.3.4)
- Main memory (See Section 2.3.5)
- Shared memory (See Section 2.3.6)
- Fast-path memory (See Section 2.3.7)
- Boot PROM (See Section 2.3.8)
- ID PROM (See Section 2.3.9)
- Non-Volatile RAM (NVRAM) and Clock (See Section 2.3.10)
- Proprietary Bus Memory Interface ASICs (See Section 2.3.1.4)
- Central Processing Units (CPUs) (See Section 2.3.1.5)

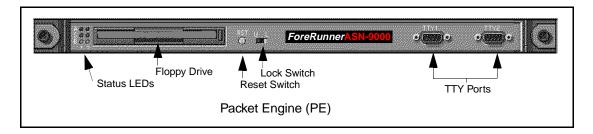


Figure 2.3 - ASN-9000 Packet Engine

2.3.1 Packet Engine

The Packet Engine (PE) contains 3 CPUs, when a Packet Accelerator is installed, and only supports the two-channel backplane. The PE is shown in Figure 2.3.

2.3.1.1 Packet Engine Status LEDs

A series of Status LEDs provide visual status of what is happening within the Packet Engine. Table 2.2 describes the function of the status LEDs.

The PE has two columns of LEDs. Each column provides status information for one of the two RISC processors.

Label	Color	Indicates this condition.
A	Red	Alarm . Indicates that a system crash has occurred. One or all LEDs remain lit until the system is reset. To reset the system, press the reset (RST) switch or switch the power supplies off and then on.
S	Green	Status . Indicates CPUs are functioning normally. If the left LED goes out during normal operation, there might be a problem in the Packet Engine.
В	Amber	Boot . Indicates the system is booting. These LEDs are lit only during the booting process and go out as soon as booting is complete.

Table 2.1 - Packet Engine LEDs

2.3.1.2 Floppy Disk Drive

The floppy disk drive accepts 1.4 MB MS-DOS formatted diskettes. Various file management tasks including displaying, copying, renaming, and removing files can be performed using the floppy disk drive as a source or destination of the file. However, the ASN-9000 file system does not support hierarchical directory structures.

Generally, the floppy drive is only used to perform software upgrades, save changes to, read configuration or environment files, or to boot the system. The floppy drive is not used during normal, unattended operation. However, if the system is configured to boot from a floppy diskette, the proper image(s) are on the diskette. If the system is loaded from floppy diskette, the floppy disk must be inserted in the floppy disk drive at all times.

The ASN-9000 supports two alternatives to booting from floppy disk: (1) netbooting over the network from a TFTP server, or (2) from the Flash Memory Module. See Section 2.3.1.3.



If more than one intelligent NIM is installed, or the one intelligent NIM installed is an ATM NIM, the software image is too large to fit on one floppy diskette, and the system must be loaded from the Flash Memory Module or a TFTP server.

2.3.1.3 Flash Memory Module

The PE in an ASN-9000 ships with a 4MB Flash Memory Module. The Flash Memory Module stores configuration settings and boot information and is required if the ASN-9000 is not booted over the network. Software can be loaded into the Flash Memory Module through a tftp session or by copying the files from a floppy diskette. Use of the Flash Memory Module allows for fast system booting. See *Chapter 5, Installation, Upgrade, and Removal Procedures* for information about installation and removal of the Flash Memory Module.

2.3.1.4 Proprietary Bus-Memory Interface ASICs on PE

FORE Systems' proprietary BMW (Bus Memory Wide) ASICs and Bus-Memory Interface (BMI) ASICs provide multiple ports for Packet Channels and CPUs to access Shared Memory. The Packet Engine (PE) contains four BMI ASICs which support two Packet Channel ports (X and Y), each providing 800Mb/s of peak bandwidth and two CPU ports (CPU1 and CPU2), connecting to the MCPU and IOP CPUs. Access to Shared Memory ports is prioritized. The CPU ports have the highest priority, followed by the Packet Channel ports.

2.3.1.5 PE Central Processing Units

The Packet Engine contains CPUs that perform different functions. The PE contains two RISC CPUs, each with specialized functions.

2.3.1.5.1 Input/Output Processor (IOP)

The IOP CPU handles real-time processing for network interface chips, including initialization, error handling, packet reception, packet transmission, and buffer management.

2.3.1.5.2 Main CPU (MCPU)

The MCPU runs packet forwarding algorithms, used for MAC-layer bridging and multiprotocol routing. In addition, this CPU runs management software, including an SNMP agent. When a Packet Accelerator is used, a second MCPU and a second IOP are added to the Packet Engine.

2.3.2 Reset Switch

The reset switch can be used to reboot the system. When the reset switch is pressed, the Packet Engine performs a "cold" restart. During a cold restart, the Packet Engine conducts a power-on self-test to check various hardware components. The reset switch is located in the center of the Packet Engine, to the left of the Lock Switch.

When the Reset Switch is pressed and the system reboots, it boots according to the boot preference(s) specified. The Packet Engine uses files in the Flash Memory Module, Floppy Disk Drive, or via a TFTP server (network booting) to configure the system for runtime operation. When shipped from the factory, the system software is configured to boot from the Flash Memory Module. Refer to the *ForeRunner ASN-9000 Software Reference Manual* for information on changing the boot source.

2.3.3 Lock Switch

The Packet Engine features a Lock Switch, located on the front panel of the Packet Engine to the right of the reset (RST) button. The Lock Switch, when set to L (Locked) locks the user interface so that a login ID and password are required before a user can access the command-line interface. The switch is disabled or set to Unlocked (U) at the factory, which allows anyone to establish a connection to the ASN-9000 and access the user interface.

The PE contains a Lock Switch Jumper which can be used to override the Lock Switch. Refer to *Chapter 5, Installation, Upgrade, and Removal Procedures*, for procedures on changing or setting the Lock Switch and Lock Switch Jumper.

When the Lock Switch (or Lock Switch jumper) is set to Locked, a password is required to obtain management capability. Management capability can be monitor or root: Refer to *Chapter 6, Boot PROM Commands* for procedures on changing or setting passwords.

- Monitor Allows displaying of information, but does not allow statistics to be cleared or configuration settings to be changed.
- **Root** Allows unrestricted access to the system, including issuing commands that clear statistics and change the configuration.

2.3.3.1 RS-232 Ports

The Packet Engine supports two TTY ports, labeled TTY1 and TTY2. Each port provides an RS-232 connection to the ASN-9000. These ports are used to attach management terminals or modems to the ASN-9000. Each port supports the following asynchronous modem-control lines: RXD, TXD, DCD, DTR, RTS, and CTS., and baud rates of 1200, 2400, 4800, 9600, or 19200.

To ensure session security, the TTY ports use data carrier detect (DCD). If the terminal or modem connected to the TTY port is supplying the DCD signal, the ASN-9000 monitors that signal. If DCD is dropped, the software logs the user out of the session. This prevents other terminals or modems from connecting to the session.

If the terminal or modem does not supply a DCD signal, the TTY port can still be used. The Packet Engine has "weak pull-up" resistors that supply the DCD signal internally. (However, if the cable contains another signal where the DCD signal is supposed to be, the cable might prevent proper operation of the TTY port. Refer to *Appendix A, Pinouts* for the pinouts of the TTY1 and TTY2 ports.)

When the system boots, it automatically begins a command-line session on the terminal or modem connected to the TTY1 port. Note that the first time logging on, the modem or management terminal attached to TTY1 must be set to 9600 baud.

See *Chapter 3*, *Quickstart* for instructions on attaching the management terminal or modem to the TTY ports. This section also describes how to assemble an RS-232 cable to connect to the TTY ports.

2.3.4 Temperature Sensor

A temperature sensor is available on each module installed in the chassis. The temperature sensor reads the temperature of the module, within an accuracy of plus or minus 0.5° C. The system temperature | temp command can be issued at any time to read the current operating temperature of a particular module or all installed modules. (Refer to the ForeRunner ASN-9000 Software Reference Manual for more information on displaying the temperature.)

2.3.5 Main Memory

Each Packet Engine ships with 32MB of main memory in the form of dynamic random access memory (DRAM). This standard memory configuration is sufficient to support Bridging, IP routing, IP Multicast, IPX, AppleTalk, DECnet, and the Bridge MIB.

2.3.6 Shared Memory

The Packet Engine contains Shared Memory that provides 800Mb/s of bandwidth, more than enough to support a fully-loaded ASN-9000. The ASN-9000 is equipped with 2MB Shared Memory.

The RISC CPUs and Packet Channels use the Shared Memory to store packets and related data structures. Because all packet-related data is stored in one place, the system can maintain a high packets-per-second throughput.

2.3.7 Fast Path Memory

In addition to their own on-chip caches, each CPU can access private "fast-path" memory that stores the most performance-critical code and data. Additional resources that can be accessed by both CPUs are described in the following sections. These additional resources are used mostly by the MCPU.

2.3.8 Boot Programmable Read-Only Memory

The Packet Engine also contains a Boot Programmable Read-Only Memory (Boot PROM) that contains software used by the Packet Engine when booting the system. Software commands can be issued to the Boot PROM to perform configuration tasks such as specifying a boot source and installing software upgrades. Refer to *Chapter 6, Boot PROM Commands* for a description of the Boot PROM commands. The command prompt for the boot PROM is shown <PROM-9pe>..

2.3.9 ID PROM

The Packet Engine and all NIMs contain an ID PROM located in a reserved area in the Boot PROM that contains identification information of the module and lists the maximum amount of current required to power the module. The ID PROM lists the module's serial number, model number, hardware revision, and other factory-issued information. To display the contents of the ID PROM use the system idprom command. (Refer to the ForeRunner ASN-9000 Software Reference Manual for more information on the ID PROM.)

2.3.10 Non-Volatile RAM (NVRAM) and Clock

The Non-volatile RAM (NVRAM) contains a battery-operated 8K CMOS RAM and time-of-day clock. NVRAM maintains the system time and date and contains configuration information such as the TTY port baud rates, the system name, and boot source.

NVRAM can be configured to contain additional configuration information used in some implementations of network booting. Refer to the *ForeRunner ASN-9000 Software Reference Manual* for information on NVRAM commands.

NVRAM can be accessed from either the Boot PROM command prompt or the run-time command prompt. Refer to *Chapter 6, Boot PROM Commands* for information about the Boot PROM commands used to configure NVRAM.

2.4 Power Modules

The ASN-9000 supports two AC and one DC Power Module. The ASN-9000 can also be configured to support redundant power modules and load sharing. Load sharing reduces wear on the power modules and results in longer power module life. The AC power module plugs into a standard grounded three-prong outlet. The power backplane connects the power modules to the rest of the system. The power modules are supplied with an internal fan to provide cooling for the power module components. For more information on working with the power modules, refer to *Chapter 5, Installation, Upgrade, and Removal Procedures.* The following sections discuss the power modules.

2.4.1 Load Sharing

Many configurations require only a single power module to run, but can use a secondary power module for redundancy (backup) and load sharing. When power modules load share, they participate equally in providing power. Load sharing improves the reliability of each power module participating in load sharing. In addition, if one power module ever fails, the entire load is immediately assumed by the remaining power module. As long as the remaining power module is providing sufficient current, it continues to operate without interruption.

When redundant power modules are installed, either power module can be removed without interfering with the operation of the system. As long as the chassis contains the minimum number of power modules required to support the configuration, it continues operating normally.

When a single power module is used, it must always be installed in the left power module bay. A protective coverplate must be installed in the unused bay. (Operating the system with an uncovered power module bay affects internal cooling and can void the warranty.) In the event of a short circuit or other overload condition, all power modules automatically shut down to protect the ASN-9000 from damage.

2.4.2 Live Insertion

In addition to removing a redundant or failed power module, a new power module can be inserted while the chassis is operating. This is known as live insertion. As soon as AC current is applied to the inserted power module, it begins to load share with the power module in the chassis. Refer to *Chapter 5, Installation, Upgrade, and Removal Procedures* for instructions on inserting a power module.

2.4.3 AC Power Modules

The ASN-9000 supports two AC power modules: a 283 Watt (Figure 2.4) and a 530 Watt (Figure 2.5). These power modules are interchangeable, interoperable and backwards compatible. A 530 Watt power module can be used in an older chassis, and a 283 Watt power module can be used in a new chassis. The high current power modules were designed to provide a higher degree of reliability for ASN-9000 configurations that draw more power. The new power modules achieve this by:

- Improving the cooling capacity.
- Reducing the component count by increasing current.
- Maintaining full load sharing between standard and high capacity power modules.

The power required is dependent on the number of NIMs installed and the current that each NIM draws. Both types of AC power modules can be used in the same ASN-9000 at the same time, though FORE Systems does not recommend using the standard power modules to backup high current power modules without a careful system analysis to ensure that the standard power modules are sufficient to support the load if the high current power modules fail.

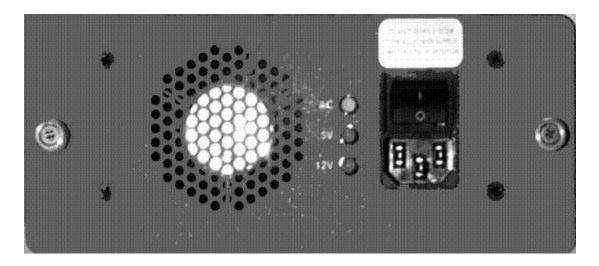


Figure 2.4 - 283 Watt Power Module

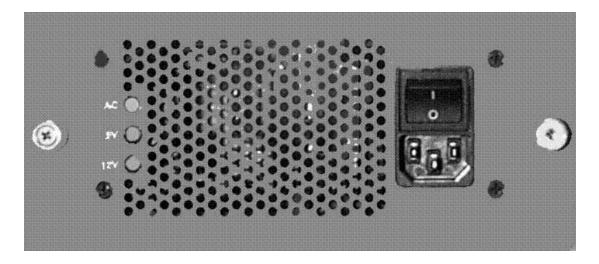


Figure 2.5 - 500 Watt Power Module

The AC power module transforms AC current into the +5- and +12-volt DC current. Each power module requires an input voltage of 85-132 volts AC (or 180-264 volts AC when used in countries using 220-volt AC standard) at 47-60 Hz.

The AC power module runs on a standard 110-volt AC or 220-volt AC power source. The power module automatically detects the input voltage, so no jumpers or switches are needed when setting up for an alternative power source. The power module is shipped with a three-wire power cable that matches the power receptacle used in the destination country. The wiring used to connect to the power source should be capable of carrying at least 10 amperes.

The AC power cord plugs into a receptacle on the front of the power supply. When more than one power module is installed, each requires its own power cable.

A power module must be installed in the primary Power Module bay before booting. In a system with two Power Module bays, the left bay houses the primary module. The other bay houses a secondary power module. The minimum number of power modules required depends upon the configuration. For information about power requirements, refer to *Chapter 4, Safety and Environmental Requirements*.

Table 2.2 - Power Supply LEDs

Label	Color	Indicates the following condition.			
AC (DC on the DC Power Supply)	Amber	Power module is receiving current from the power source. If this light is on, but the following two lights are off, a short circuit or other overload condition has occurred. Refer to <i>Chapter 4, Safety and Environmental Requirements</i> for information on resetting the module(s) following an overload condition.			
5V	Green	Power supply is supplying +5-volt power.			
12V	Green	Power supply is supplying +12-volt power.			

2.4.4 DC Power Module

The DC power module transforms DC current into the +5-volt and +12-volt DC current. Each power module requires an input voltage of 40-60 volts DC. The maximum output current of the power module is 35A at +5 volts DC and 9A at +12 volts DC.

The DC power cable consists of six wires: two black (+48V), two red (-48V), and two green (safety ground). In a normal telephone system, the +48-volt battery terminal is connected to an earth or safety ground, while the -48-volt battery terminal is floating.

When shipped from the factory, one end of the cable contains a keyed connector that plugs into the DC power module. The other end of the cable has no connector. Connect the wires to the DC power source. The ends of the wires are stripped to simplify the installation.

The power switch on the DC power module is actually a circuit breaker. When the switch is set to the ON position (marked |), the circuit is closed. When the switch is set to the OFF position (\mathbf{O}), the circuit is open.

Figure 2.6 shows the control panel of the DC power module. Notice that the LEDs are labeled differently from the AC power module, and the connector for the power cable is different.

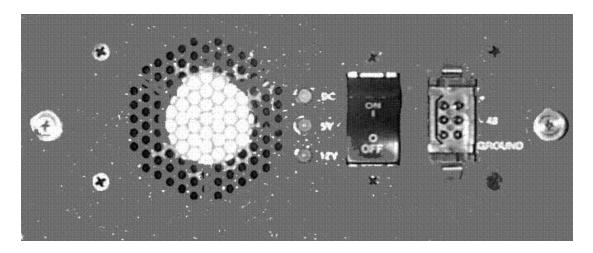


Figure 2.6 - -48Volt DC Power Supply

2.5 Fan Module

Fan modules are provided to help dissipate heat and keep the NIMs and Packet Engine at optimal operating temperatures. The fan module contains three fans providing a steady flow of air to the Packet Engine and NIMs. In the event that one fan in a module fails, the remaining two fans can provide adequate cooling.

Chassis and Packet Engine

CHAPTER 3 Quickstart

This chapter provides quickstart information to assist in getting the ASN-9000 up and running. Detailed configuration information is not provided in this chapter. Refer to the *ForeRunner ASN-9000 Software Reference Manual, ForeRunner ASN-9000 Protocols Reference Manual,* and *ForeRunner ASN-9000 Filters Reference Manual* for detailed configuration information. Some of the things discussed in this chapter include:

- · Installing the chassis.
- · Connecting the management terminal or modem.
- · Booting the system
- Allocating segments
- Configuration files

3.1 Installing the Chassis

This section describes how to install the ASN-9000 chassis. Table 3.1 shows specifications of the ASN-9000 chassis configurations. The weight is approximate and includes the maximum number of power supplies and ATM PowerCells in every slot. The actual weight may vary.

Table 3.1 - ASN-9000 Specifications

Number of Power Module	Number of Slots	Height	Weight	
2	5	8 3/4"	~65 lbs	

The chassis listed above is 17" deep and approximately 17" wide without the rack-mounting ears installed.



Before beginning to work with the chassis, read the safety and environmental requirements detailed in *Chapter 4, Safety and Environmental Requirements*.

The chassis can be installed in any of the following ways:

- On a tabletop.
- In a standard 19" equipment rack using one of the following:
 - Front-mount (closed computer rack) brackets.
 - · Center-mount (open telecom rack) brackets.

CAUTION



If the chassis is to be front-mounted in a closed rack, it is recommend that a metal strip or tray be installed to support the rear of the chassis. If the rear of the chassis is not supported, the chassis weight could break the bolts securing the mounting brackets to the rack.

The ASN-9000 is shipped with the Packet Engine, NIMs, and power modules installed. The fully-configured chassis is heavy. If the chassis is to be installed in a rack, it is recommended that the procedures in *Chapter 5, Installation, Upgrade, and Removal Procedures* be followed to temporarily remove the Packet Engine, NIMs, and power modules.

3.1.1 Installing the Chassis on a Tabletop

To install the chassis on a tabletop, prepare the tabletop to allow at least 3" of open space around the sides and in front of the chassis, then place the chassis in the space prepared. If any NIMs or the Packet Engine were removed, replace them using the procedures outlined in *Chapter 5, Installation, Upgrade, and Removal Procedures* before powering on the ASN-9000.

3.1.2 Cable Organizer

The chassis can be outfitted with a cable organizer. To install the cable organizer, align it over the two empty screw holes on the right side of the front of the chassis and attach it with the two screws provided.

3.1.3 Rack Mounting the Chassis

The chassis can be mounted in a standard 19" closed-frame rack using the angle brackets supplied. For safety reasons, install a supporting shelf below the chassis. For this type of installation, the following are needed:

- Two closed-rack mounting brackets. These mounting brackets are smaller than the
 open-frame brackets and each have twelve screw holes for the chassis and four
 screw holes for the rack.
- Eight pan-head screws, four for each bracket.
- A #2 Phillips-head screwdriver.
- · A flat-head screwdriver.



Before installing the chassis in a closed-frame rack, remove the Packet Engine, NIMs, and power modules from the chassis using the procedures in *Chapter 5, Installation, Upgrade, and Removal Procedures*

To install the chassis in a closed-frame rack:

- 1. Place the chassis on its side to access the four rubber feet on the bottom.
- 2. Remove the rubber feet.
- 3. Remove the screws from one side of the front of the chassis that align with the associated screw holes in the appropriate bracket(s).
- 4. Align one of the closed-frame brackets over the screw holes. Ensure that the flange that connects to the rack is facing toward the front of the chassis. When the bracket is correctly positioned, the flange is flush with the front of the chassis.
- 5. Insert the screws removed in Step 3. Do not over-tighten the screws; they should be hand tight.
- 6. Repeat steps 3–5 on the other side of the chassis for the other bracket.
- 7. When both brackets are installed, carefully lift the chassis into the rack, align the screw guides over the holes in the rack, then use the flat-head screwdriver to insert the eight screws provided. The screws go into the mounting holes in the brackets.
- 8. Reinstall any modules that were removed before installing the chassis, using the appropriate procedures in *Chapter 5, Installation, Upgrade, and Removal Procedures*.

3.2 Connecting a Management Terminal or Modem

The ASN-9000 is shipped with an RS-232 cable assembly kit, which contains parts to assemble the cable. Like most RS-232 connections, the TTY ports are wired as DTE (Data Terminal Equipment). Refer to Figure 3.1 for an illustration of how to assemble the necessary management terminal or modem cable assembly.



If the management terminal requires a DTE connection, a null modem or other means to swap the signal pairs cable may be required.

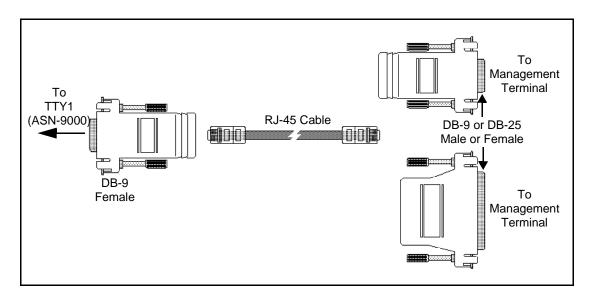


Figure 3.1 - TTY Port Cable Assemblies

The initial login requires that the modem or management terminal attached to TTY1 must be set to 9600 baud



To use the TTY2 port, in addition to TTY1, an additional cable is required. Contact FORE Systems TAC about ordering an additional adapter kit for the TTY2 cable.

1. To connect a management terminal or modem, determine the type of connector needed for the management terminal or modem side of the connection. E.g, a terminal whose serial port is a female DB-9 needs a male DB-9 connector. If the management terminal or modem port is wired as DTE, use a null modem or some other means to swap the RS-232 signal pairs as indicated in Figure 3.2.

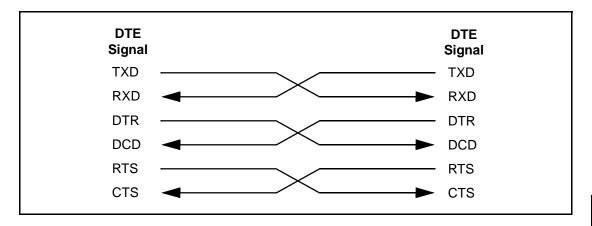


Figure 3.2 - DTE Null Modem Connections



One way to swap the signal pairs is to wire the connector or management terminal as DCE.

- 2. Select the RJ-45 cable and/or DB-9 or DB-25 connector shell that fits the terminal or modem serial port from the assembly kit.
- 3. Using Table 3.2, assemble the connector. For example, if a DB-9 connection to a PC DTE is needed, and a null-modem function is to be incorporated in the cable, use the DB-9 column on the Modem Signal (DCE) side of Table 3.2.
- 4. Set the serial port on the modem or management terminal to 9600 baud.
- 5. Plug the RJ-45 connector into the management terminal or modem connector just assembled.
- 6. Plug the management terminal or modem connector into the management terminal or modem.
- 7. Plug the female DB-9 connector into the TTY1 port and the RJ-45 connector into the DB-9 in the TTY1 port.

Table 3.2 - RS-232 (TTY) Pinout Reference

RJ-45*	Terminal (DTE)	DB-25	DB-9	Modem (DCE)	DB-25	DB-9
6 (Yellow)	TXD	3	2	TXD	2	3
3 (Black)	RXD	2	3	RXD	3	2
4 (Red)	GND	7	5	GND	7	5
7 (Brown)	DTR	6	6	DTR	20	4
5 (Green)	DCD	20	4	DCD	8	1
8 (White)	RTS	5	8	RTS	4	7
1 (Blue)	CTS	4	7	CTS	5	8
2 (Orange)	n/a	n/a	n/a	DSR	6	6

^{*} The colors refer to the wires inside the connector shells, not the wires in the cable itself.

3.3 Booting the System

There are four different ways to boot the ASN-9000 software. The software can be loaded by:

- Turning on the power supplies.
- Pressing the Reset Switch (RST) on the Packet Engine.
- Issuing the boot | b command from the Boot PROM (<PE1>)prompt (refer to Chapter 6, Boot PROM Commands for more information on the boot | b command).
- Issuing the reboot command from the system (ASN-9000:system#) prompt (refer to the *ForeRunner ASN-9000 Software Reference Manual* for more information on the reboot command).

CAUTION



Ensure that the chassis contains at least the minimum number of power modules to support the configuration. If not sure, refer to *Chapter 4*, *Safety and Environmental Requirements*. Also, make sure a power module is installed in the primary power module bay. The primary module bay is the upper-left bay.

The first two options are physically performed by either turning the power modules on or pressing the reset (RST) switch on the Packet Engine (PE). To power on the ASN-9000, do the following:

- 1. Ensure that all unused slots and bays in the chassis are covered with the proper cover plates. Operating the system without cover plates installed over unused bays or slots is unsafe, potentially damaging, and can void the warranty.
- 2. Plug the power module cables into the power modules, then into a grounded circuit(s) capable of supplying the required amount of AC or DC current.
- 3. Switch on all power modules at the same time (or at least the minimum number of modules required for the configuration). If the minimum number of power modules required are not powered on, the power modules powered on may become overloaded and shut down. To simplify this step, plug all of the power modules into a power strip or into the same circuit, then apply power to the strip or circuit to simultaneously apply power to all modules.



If a power module becomes overloaded and shuts down, switch all the power modules off to reset the ones that are overloaded, then simultaneously switch all the power modules on again.

When enough power modules are powered on to meet the configuration's power needs, the PE will conduct a power-on self-test as part of the booting procedure. When the PE boots, the Boot (B) LED flashes to indicate that the module is booting. As soon as the PE finishes booting, the Boot LED becomes dark and one of the Status (S) LEDs on the left end of the PE glows steadily, indicating that the system is ready for operation.

Messages, similar to the following, are displayed on the management terminal during the boot process.

```
Starting Packet Engine ...
Prom version: pelp-3.0.0 (7887) 1998.05.06 13:01
I-cache 16KB OK
Entering cached code
I-cache execution OK
D-cache 4KB OK
SRAM 128KB OK
DRAM 24MB OK
Shared Memory 4MB OK
Entering Monitor
FORE Systems ASN-9000
FlashInit: found 4MB Flash Memory Module
Board Type: 9PE , CpuType: MCPU, Instance: 1
Ethernet address: 00-00-ef-03-9a-b0
(normal start)
Hit any key now to abort boot [5]:
```

If the system does not boot when power is applied, check the LEDs on the power modules and PE. If no LEDs are glowing, there may be an overload in the power circuit or the system may not contain enough power modules. First check the power circuit to ensure that there is sufficient power going to the modules, then ensure that there are sufficient power modules for the configuration. For information on power requirements for different configurations, refer to *Chapter 4, Safety and Environmental Requirements*.

When the system is finished booting, the runtime command prompt is displayed. However, if the boot process is aborted, the prompt for the PE boot PROM is displayed. To resume the boot process, issue the following command at the <PROM-9PE> prompt:

b [f|m]

where: £

Boot from the Floppy Diskette.

Boot from the Flash Memory Module



If a boot source is not specified, the boot order configured in NVRAM is used. If a boot order has not been configured, the system attempts to boot first from the Flash memory Module.

3.3.1 Specifying the Boot Source

The system can be configured to boot from Floppy Diskette or Flash Memory Module . The system can be configured to use one method exclusively or to try one method first, then try one or both of the other methods.

To specify the boot source:

- 2. Enter the following command at the runtime command prompt or the Boot PROM command prompt, then press Enter:

nvram set bo <value>

where:

<value> Specific

Specifies the boot source(s). Valid boot sources are:

f Floppy diskette

mFlash Memory Module

If more than one boot source is specified, the system attempts them in the order specified. (Ex: if **fm** is entered, the Floppy Diskette is the first boot source option, then the Flash Memory Module.)



A valid configuration file must be present on the designated netboot device before booting off the network device can occur.

3.4 Allocating Segments

When shipped, the ASN-9000 is configured to recognize the maximum allowable segments per NIM in the chassis. If the chassis does not contain modules whose total segment count exceed the maximum allowable segments, 96 for the ASN-9000, the default segment allocations work for this system. However, if the chassis contains modules that exceed the allowable segment count, segments on some NIMs must be explicitly allocated or the additional segments are ignored. Refer to Chapter 6, Boot PROM Commands for information on allocating segments from the Boot PROM (<PROM-9PE>) prompt or the ForeRunner ASN-9000 Software Manual on allocating segments from a runtime (:ASN-9000:nvram#) prompt. Enter the maximum, or desired number up to the maximum. ATM PowerCells in the ASN-9000 can accommodate up to a maximum of 32 segments each. If four ATM PowerCells are installed, it is necessary to reduce the segment count on one or all PowerCells so that the maximum of 96 is not exceeded.



Installing Intelligent ATM PowerCells above the allowable segment count for the specific chassis causes an error condition to occur. It is advisable to remove any unused ATM PowerCells installed above the maximum allowable segment count.

Segment allocations are stored in NVRAM on the Packet Engine. If the Packet Engine is changed for any reason, the segments need to be re-allocated and the values stored in NVRAM in the new Packet Engine.

3.4.1 Verifying Segment Allocations

To display the current segment allocations to a particular ATM PowerCell slot or all installed ATM PowerCells, issue the following command:

slotsegs[<n>] [show]

where:

[<n>]

Specifies the slot number. This argument is optional. If the slot number is not specified, segment allocations for all slots are displayed.



If this command is used with the slot argument, the brackets around the slot number must be included.

3.4.2 Attaching Network Segments

To attach network segments, simply plug the segment cables into the appropriate segment connectors.

3.4.3 Enabling Automatic Segment-State Detection

Automatic-segment state detection enables the software to note changes in the state of segments (whether they go up or come down). This software automatically enables bridging and routing on segments that are active and marks the changes in corresponding table displays. (See *ForeRunner ASN-9000 Software Reference Manual* for more information about Automatic segment-state detection.

3.5 Saving the Configuration

When the system boots, the software looks for a configuration file on the device specified as the boot source. When the configuration file is read, the configuration changes saved in the file are reinstated. A configuration file name can be specified in the boot definition file:

- If the system boots from the Flash Memory Module, the bootdef file identifies a configuration file. By default, the bootdef file identifies the name cfg. (The default configuration name in the boot definition file can be changed by editing the file.)
- If the system boots from a BOOTP/TFTP server, the boot definition file identifies a file named <*file-name*>.cfg, where <*file-name*> identifies the system. Depending on how netbooting is configured, a descriptive string or the MAC-layer hardware address may be specified.



If more than one boot source is to be used, it is recommended that the same configuration be saved to each boot source. These procedures are described below. To avoid potential problems, ensure that the configuration files on all boot sources match.

3.5.1 Saving the Configuration File

Configuration files can be saved to the Flash Memory Module on the Packet Engine to allow faster booting. The 4MB Flash Memory Module is standard on a PE. To save the current configuration to the Flash Memory Module:

1. Boot the software. Following the boot messages, a command prompt is displayed.



The software must be successfully loaded before saving the configuration. The configuration cannot be saved from a Boot PROM prompt.

2. Type the following command at the system prompt, then press Enter:

savecfg cfg

The savecfg cfg command saves the configuration to a file named cfg in the Flash Memory Module. Any DOS-like filename can be specified. If the filename does not match the name in the bootdef file (cfg), the configuration must be loaded manually each time the software is loaded by using the system readcfg command. (See the ForeRunner ASN-9000 Software Reference Manual for more information on system commands.)



Safety and Environmental Requirements

This chapter provides a summary of the safety and handling precautions for handling the ASN-9000 and its components. The following safety and handling guidelines are discussed:

- Electro-Static Discharge (ESD)
- Avoiding personal injury
- Guarding against damage
- Preventing damage to connector pins
- Securing thumbscrews
- Care of fiber-optic systems and cables

Additionally, this chapter discusses environmental and power requirements for the proper use of the ASN-9000.

4.1 Safety Requirements

4.1.1 Electro-Static Discharge

Electronic components can be damaged through improper handling. One of the most common, although unintentional, types of mishandling is Electro-Static discharge (ESD). ESD can permanently damage electronic components. ESD straps should be worn when performing the hardware procedures explained in this chapter. Carefully read all of Section 4.1.3 for details. ESD can occur when the equipment being handled and the individual handling the equipment are at different voltage potentials. When coming into contact with the equipment, the difference in potential can cause energy to be passed from the individual to the component, delivering a shock.

The human body is a good conductor of electricity and can deliver shocks containing thousands of volts. In fact, most people perceive a static shock only when the voltage of the shock is at least 6,000 volts. However, many electronic components can be damaged by shocks as low as 2,000 volts.

4.1.2 Avoiding Personal Injury

Use care and common sense when handling modules. Improper handling of modules can result in damage to the components or personal injury. To avoid personal injury:

- Do not immerse components in water.
- Do not stand on a wet surface while inserting or removing modules.
- Always cover unused slots or bays with the supplied cover plates. Never place tools, or any body part inside empty power module bays or module slots.

4.1.3 Guarding Against Damage

After the chassis, the work surface, and any loose components are grounded, touch the chassis or the work surface containing the components before touching the components themselves. To guard against damaging modules, always take the following precautions:

- Wear an anti-static wrist guard. Make sure the wrist guard directly touches the skin. To insure against ground faults, use a wrist guard that has a $1M\Omega$ (one megohm) resistor.
- Always store modules in their original packaging.
- Never operate the system with exposed power module bays or ATM PowerCell slots. Operating the unit without cover plates installed over unused bays or slots voids the warranty.
- Handle the modules only by their edges. Never directly touch components on the modules.
- Never remove a module from its protective packaging or from a chassis until the
 chassis and the work surface are properly grounded. If the work surface is metallic, ground it by attaching a wire from the surface to the electric ground in the
 building. If the work surface is not metallic, use a ground-conductive rubber mat
 as the work surface.



Low humidity levels can increase the danger of ESD. Use extra caution if the ASN-9000 is in a low-humidity environment.

After the chassis and any loose components are grounded, touch the chassis or
work surface containing the component, before touching the component itself. In
this way, any charge is neutralized before it can damage the component. Note that
the chassis or other surface must be grounded for this to be effective.

4.1.4 Preventing Pin Damage

Use care when handling modules that have connector pins. Modules such as the Packet Channel Backplane and the power backplane contain many small pins that plug into headers in other modules. These pins can be bent if the modules are mishandled, or if excessive force is used to seat the modules' pins in a header.

Pin damage caused by mishandling is not covered by warranty. If a pin is accidentally bent, to prevent the pin from becoming broken, carefully bend it back into position before attempting to seat the module.

4.1.5 Tightening Thumbscrews

Always use the appropriate screwdriver to tighten thumbscrews on the modules. If a screwdriver is not used to tighten the thumbscrews, the modules can come loose through ordinary vibration, such as when installing cables or moving adjacent modules and cover plates. The thumbscrews on the Packet Engine and ATM PowerCells require a regular flat-head screwdriver. The power modules require a #2 Phillips-head screwdriver.

4.1.6 Care of Fiber-Optic Systems and Cables

In addition to the general precautions discussed above, fiber-optic systems require additional precautions.

Always use care when connecting fiber optic cables. Although they look like standard copper cables, they are delicate. Avoid repeated sharp bending of fiber optic cables since it can cause micro-cracking of the glass fiber. Be particularly careful of the open ends of the uncovered connectors. Make sure that the connector surfaces are not dragged along the floor or dropped onto hard or abrasive surfaces. The best practice is to keep the factory supplied dust covers on all unused fiber connectors and optical components.

4.2 Environment Requirements

The system is designed to operate within a temperature range of 0° to 40° C (32° to 104° F) and at 10 to 90 percent relative humidity, non-condensing. The corresponding storage requirements are -20° to 55° C (-4° to 131° F) and 90 percent maximum relative humidity, non-condensing.

To ensure adequate air flow for cooling, maintain at least a 3" clearance on either side and the front. Operating the system without adequate clearance for cooling voids the warranty.

4.2.1 Acoustic Noise Levels

Table 4.1 lists the acoustic noise levels for a fully-loaded system including the fan modules.

Table 4.1 - Acoustic Noise Levels

Chassis	Noise Level
5-slot chassis with two active power modules	~40 dbA at one meter

The measured noise may vary by plus or minus 3 dbA from these levels for any particular system.

4.3 Power Requirements

The power requirements are determined by the number of populated slots. A fully populated ASN-9000 can support up to 4 ATM PowerCells and up to two power modules. The following sections identify the power requirements so that the power produced by the power modules is sufficient. The following sections specify the power requirements and the power produced by the power modules.

The number of power modules needed by a specific chassis depends upon its configuration—both the number and types of installed modules and whether redundant power operation is desired. In any case, the first step in determining the number of power modules needed is to determine the total power requirements of the modules in the configuration.

Modules may consume power at two different voltages, +5-volts and +12-volts. Power needs are determined based on the greater of the +5-volt and +12-volt power requirements. The requirements are identical regardless of whether the current is being supplied by AC or DC power modules.

4.3.1 +5-Volt Current Requirements

Power requirements are calculated by adding the current requirements of all the modules in the system. Technically, the actual power requirement in watts is the supply voltage times the current requirement in amperes; generally, this distinction is only relevant to electrical engineers.

Table 4.2 lists the current requirements, in amperes (A), required from the +5-volt power system by each module. The total +5-volt current required by a particular configuration is determined by adding the +5-volt current requirements of all installed modules, being careful to account for multiple instances of each module type.

Module Type	+5 V
Packet Engine	10.0A
PowerCell 700 ATM Module with 1 PHY (AMA)	7.5A
PowerCell 700 ATM Module with 2 PHYs (AMAs)	8.0A

Table 4.2 - ASN-9000 +5-Volt Requirements

4.3.2 +12-Volt Current Requirements

The only +12-volt requirement of the ASN-9000 is the fan module, and it is rated at 1.0A.

4.3.3 Nonredundant and Redundant Power Configurations

The system can be configured to provide, or not provide, redundant power. FORE Systems recommends power redundancy, which provides for backup power if one power module fails. FORE Systems' redundant power design allows the system to continue running without interruption if a single power module fails or is removed. In addition, live insertion of modules requires that a redundant power module is present.

If the system does not have a redundant power module and a power module fails, remaining power modules may become overloaded and shut down to protect themselves from damage. If this happens, perform the following:

- Disconnect the power.
- Determine which power module is bad.
- · Replace the bad power module.
- · Reapply power to the system.

By installing a redundant power module, this type of problem is avoided. A redundant power module ensures that if a power module fails, the system continues to operate normally. Since the system continues operating, unlit LEDs on a bad power module identify where the problem is so that it can be easily corrected.

4.3.4 Determining the Number of Nonredundant Power Modules

The ASN-9000 supports two different power modules. One AC module, which produces 283 Watts and one 48-Volt DC module which produces the same current as the 283 Watt power supply.

The 283 Watt AC and 48 Volt DC power modules are rated to continuously deliver 35A @ +5-volt and 9A @ +12-volt. However, for conservative operation in nonredundant configurations, FORE Systems recommends that the modules be de-rated to approximately 90% of full capacity when calculating current usage. De-rating the power usage reduces long-term stress on the modules and improves reliability.

Table 4.3 shows the capacity of the 283 Watt power modules. To determine the power requirements, add the amount of current the installed modules draw and divide the number by the current capacity of the power module to get the number of power modules needed. For example, in Table 4.3, the total +5-volt current requirement is 25A. The total +12-volt current requirement is 4.8A. The number of power modules required for a nonredundant configuration for either 25.0A at +5-volts or 4.8A at +12-volts is 1 (25A/35A < 1 and 4.8/9 < 1).

+5V Current (in Amps)	+12V Current (in Amps)	Nonredundant	Redundant
0 - 35	0 - 9	1	2

Table 4.3 - 283 Watt Power Module Requirements

4.3.4.1 Determining the Number of Redundant Power Modules

The fourth column of Table 4.3 show the number of modules required in a redundant configuration as a function of the +5-volt and +12-volt current requirements.

Using the fourth column in Table 4.3, the number of power modules required to satisfy the current requirement at either voltage in a redundant configuration is 2.

During normal operation of a redundant configuration, each module operates well below its maximum capacity. This is true because the power system provides load-sharing, so that each installed module handles an equal share of the total load presented to the power system.

In a redundant configuration, if one module fails or is otherwise not operating, the remaining modules take up the load. This allows for the hot-swapping and replacement of failed power modules while the system is operating. When a new power module is added, the system immediately begins to load share between all installed power modules.

If a power module in a redundant configuration should fail, increasing the load on the remaining power supplies to the threshold of their capacities, it is important to repair or replace the failed module quickly. This is necessary not only to reinstate redundancy, but also to return the power system to a more conservative operation, further improving its reliability.

CAUTION



If only one module is to be installed, always install the module in the primary power-module bay. Otherwise, during live insertion of a module, transients may cause the entire switch to reset. The primary power-module bay is designed to prevent this from occurring. The primary power module bay is the upper-left bay.

Safety and Environmental Requirements



Installation, Upgrade, and Removal Procedures

This chapter provides procedures for installation, upgrade, and removal of the Packet Engine, PE components, Network Interface Modules (NIMs), Media Adapters and power modules. Individual sections within this chapter may contain cross-references to other chapters in this manual. The chapters referred to provide detailed information on the specific components as listed below:

- Chassis and Packet Engine (Chapter 2, Chassis and Packet Engine)
- ATM Interfaces (Chapter 7, ATM Interfaces)

5.1 Packet Engine and NIMs

The following sections provide procedures on the removal and installation of the Packet Engine and NIMs (hereinafter referred to as module). The tools required for this procedure are:

- ESD wrist strap
- Medium flat-blade screwdriver
- #2 Phillips screwdriver
- Grounded work surface, such as a grounded metal table or a table covered with a grounded, rubberized mat.

5.1.1 Installing a Packet Engine or NIM

CAUTION



Static electricity can damage the electronic components. Refer to *Chapter 4, Safety and Environmental Requirements* for the appropriate precautions to be taken when handling components.

1. If the slot in which the module is to be installed is not covered with a cover plate, go to step 2. If the slot has a cover plate, use the Phillips screwdriver to remove the two screws securing the cover in place.

WARNING!



Always power off the ASN-9000 if installing a Packet Engine.



If installing a NIM in an empty slot or installing a NIM that is of a different type than the one currently installed, power off the ASN-9000 before installing the NIM.

- 2. If installing the NIM in an empty slot, go to the step 3. If the slot is not empty, remove the NIM from the slot before installing the new NIM. Refer to Section 5.1.2 for procedures to remove a module.
- 3. Holding the module by its plated edges, align the rear corners of the module in the grooves on either side of the slot. The groove is just below the screw holes for the thumbscrews, as shown in Figure 5.1.

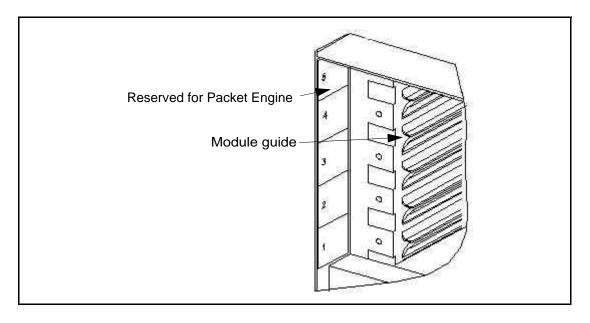


Figure 5.1 - Module Card Guides

CAUTION



Do not touch the components on the module. The Packet Engine installs in slot 5.

- 4. Slide the module at least two-thirds of the way into the slot. Do not force the module. If it does not slide easily, remove it and try again.
- 5. Grasp the ejector handles on each end of the module, making sure the handles point back away from the chassis, and push the module the rest of the way into the slot. When the module is in place, the front panel is flush with the other modules or cover plates in the chassis.

CAUTION



Some modules have an activation switch, located behind the ejector handle on the left side of the module. If an activation switch is present on the module, the ejector handle must be pressing on the activation switch for the module to operate. When installing the module, make sure the ejector handles are pressed firmly into place.

- 6. Secure the module in place by pressing the ejector handles against the front panel.
- 7. Use the flat-head screwdriver to tighten the thumbscrews.

CAUTION



The thumbscrews must be tightened to prevent the module from coming loose through ordinary vibration. If the module becomes loose, the activation switch becomes disengaged. When this happens, the module automatically shuts down.

8. If the card-swap disable command was used to remove a NIM from this slot and the same type of NIM is being installed, use the card-swap enable command from the system runtime command prompt to notify the system that the NIM has been replaced.

enable card-swap|cs <slot>

where: <*slot>* is the number of the slot in which the NIM is installed.

9. Attach/reattach network segments to the NIMs or the management terminal to the Packet Engine.

5.1.2 Removing a Packet Engine or NIM

CAUTION



Static electricity can damage the electronic components. Refer to *Chapter 4, Safety and Environmental Requirements* for the appropriate precautions to be taken when handling components.

- 1. Disconnect all management and/or network cables from the module being removed.
- 2. Perform one of the following:
 - If removing a Packet Engine, power off the ASN-9000.
 - If removing a NIM and replacing it with a NIM of a different type, power off the ASN-9000.
 - If removing a NIM, and replacing it with a NIM of the same type, from the system subsystem, issue the card-swap command. To remove a NIM, issue:

card-swap disable <slot>

where: <*slot*> is the number of the slot in which the NIM is installed.

- 3. Using the flat blade screwdriver, loosen the thumbscrews securing the module in the chassis.
- 4. Lift the ejector handles by carefully pulling them away from the module.
- 5. Grasp the ejector handles and pull the module out until it is about one half of the way out of the chassis.
- 6. Holding the module by its plated edges, remove it from the chassis and set it on a grounded work surface or anti-static bag.

5.1.3 Live Insertion of Modules

Modules can be inserted, or "hot swapped," while the ASN-9000 is powered up if the modules are of the same type, e.g. a FDDI module is replaced with another FDDI module. If you are replacing one module with a different type of module, the ASN-9000 needs to be powered down first. Live insertion requires power redundancy. In addition, it may be necessary to calculate the power supply needed to support the present modules during a live insertion as the

module inserted will initially draw excess power away form existing modules. For specific direction for calculating power supply needs, see the Configuration Guide accessible on the Product Marketing web site.

To do a card swap, use the card swap card-swap|cs enable|disable <slot> command in the system subsystem.

5.2 Packet Engine (PE) Components

The PE contains several replaceable components. These include:

- Flash Memory Module
- Packet Accelerator

The following paragraphs provide procedures for the installation and removal of these components. Refer to Figure 5.2 when performing these procedures for the physical location of these components.

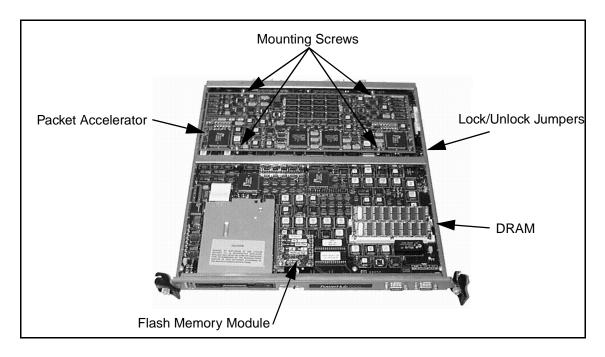


Figure 5.2 - Packet Engine (PE)

5.2.1 Installing, Upgrading, and Removing Flash Memory

The following procedures describe how to install or remove the Flash Memory Module on a Packet Engine (PE). A #2 Phillips screwdriver is the only tool required to perform this procedure. Figure 5.2 shows the location of the Flash Memory Module. Figure 5.4 shows the screw that secures it to the PE. Refer to this figure while performing this procedure.

CAUTION



Static electricity can damage the electronic components. Refer to *Chapter 4, Safety and Environmental Requirements* for the appropriate precautions to be taken when handling components.

5.2.1.1 Upgrading the Flash Memory Module

The following kit is required to perform this upgrade:

- Flash Memory Module Upgrade Kit 7160-02-7
- 1. Verify if the Packet Engine currently contains a Flash Memory Module by issuing the system dir fm:, or mgmt dir fm:, command, as shown below.

1:ASN-9000:system# dir fm:

Volume in device is 4MB FLASH 7PE 1443561 4-27-1998 8:16a 598578 4-27-1998 7ATM 8:16a 7FDDI 149856 4-27-1998 8:17a 7FETH 75770 4-27-1998 8:17a 28622 4-08-1998 7:51a CFG 5 File(s) 1766912 bytes free

2:ASN-9000:system#

- 2. If a Flash Memory Module is currently installed, the first line of the display describes the logical size of the module. If the volume states 4MB FLASH an upgrade is not required.
- 3. If the volume states less than 4MB, or an error message stating that a device driver is not present, goto step 4.
- 4. Power off the system.
- 5. Remove the Packet Engine from the chassis.
- 6. If a Flash Memory Module is installed, remove it by removing the mounting screw and lifting the module free, then go to step 8.
- 7. If no Flash Memory Module is installed go to step 8.

- 8. Remove the Flash Memory Module from its protective packaging.
- 9. Orient the Flash Memory Module so that the mounting stud is visible through the corresponding mounting hole in the module.
- 10. Gently press down on the module when the headers are properly aligned over the pins on the PE1.
- 11. When the module is completely seated on the pins, insert the supplied screw into the stand-off and tighten.

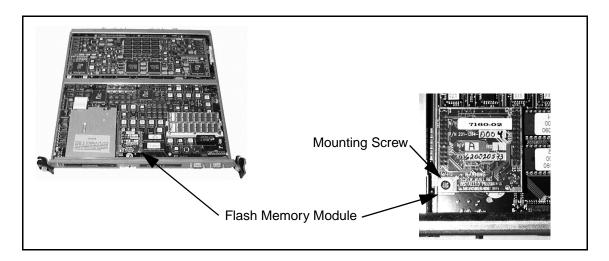


Figure 5.3 - Packet Engine 1 (PE1) Components

- 12. Reinsert the Packet Engine in the chassis.
- 13. Power on the system.



If file management commands consistently return an error message, such as, <command>: -65, where <command> is the command attempted, it is necessary to format the Flash Memory module. To format the module, issue the format fm: command (refer to the ForeRunner ASN-9000 Software Reference Manual).

5.2.1.2 Upgrading Packet Engine Memory

One of the following kits are required to perform this upgrade:

- Memory Upgrade Kit 2700-16 (for 7101-02), or
- Memory Upgrade Kit 2700-32 (for 7101-01)
- 1. Verify the amount of memory currently installed on the Packet Engine by using the system config, or mgmt scf, command.

1:ASN-9000:system# config

Accelerator board is present. Accelerator IOP is being used.

Installed DRAM Size: 24 MB

- 2. If less than 32MB is reported, go to step 4.
- 3. If 32MB, or greater, is reported no memory upgrade is required.
- 4. Power off the chassis.
- 5. Remove the Packet Engine from the chassis.
- 6. Compare the illustrations in Figure 5.2 to the removed Packet Engine and locate the appropriate SIMM socket(s).
- 7. If the Packet Engine is a 7101-01, go to step 9.
- 8. If the Packet Engine is a 7101-02, go to step 12.

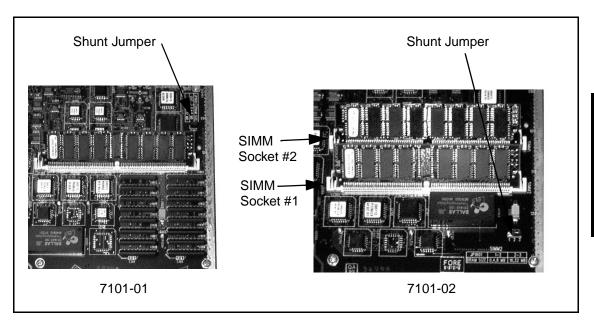


Figure 5.4 - Packet Engine Memory Locations

- 9. If 8MB was reported in step 1 and no SIMM is present in the SIMM socket, install the SIMM in Memory Upgrade Kit 2700-32, otherwise go to step 10.
- 10. If 16MB was reported in step 1, remove the SIMM that is installed and replace it with the SIMM from Memory upgrade Kit 2700-32.
- 11. Verify, or install if missing, a shunt jumper is installed across the pins of JP1601 (see Figure 5.2).
- 12. If 16MB was reported in step 1 and only one SIMM is installed in SIMM socket 1, install the SIMM from Memory Upgrade Kit 2700-16 in SIMM Socket #2.
- 13. If <32MB was reported in step 1 and there are two SIMMs installed, remove the SIMM in SIMM Socket #2 and replace it with the SIMM from Memory Upgrade Kit 2700-16.
- 14. Verify, or install if missing, that a shunt jumper is installed across pins 2 and 3 of JP1601 (see Figure 5.2).
- 15. Reinsert the Packet Engine into the chassis.
- 16. Power-on the chassis.

Repeat step 1 when the system has completed loading to verify the amount of DRAM installed.

5.2.2 Installing or Removing a Packet Accelerator

CAUTION



Static electricity can damage the electronic components. Refer to *Chapter 4, Safety and Environmental Requirements* for the appropriate precautions to be taken when handling components.

The following procedures describe how to install, upgrade, and remove the Packet Accelerator on a Packet Engine (PE). A #2 Phillips screwdriver is the only tool required to perform these procedures. Figure 5.2 shows the location of the Packet Accelerator and the screws that secure it to the PE. Refer to this figure while performing this procedure.

5.2.2.1 Installing a Packet Accelerator

The following procedures describe how to install a Packet Accelerator. Refer to Figure 5.2 for the location of the Packet Accelerator and mounting screws.

- 1. Follow the procedure in Section 5.1.2 to remove the PE from the chassis.
- 2. Remove the Packet Accelerator from its protective packaging.
- 3. Holding the Packet Accelerator by its edges, align the two connector receptacles over the corresponding sockets on the Packet Engine. Verify that the alignment is correct by sighting the four standoffs on the Packet Engine through the corresponding holes in the Packet Accelerator.
- 4. Make sure the Packet Accelerator is oriented correctly. It is oriented correctly when the serial number and version information are right-side up with respect to the front of the chassis, and the screw holes are aligned as described in step 3.
- 5. Gently press down on the rear of the Packet Accelerator when the headers are properly aligned over the pins on the PE.
- 6. When the Packet Accelerator is completely seated on the pins, insert the supplied screws into the stand-offs and tighten.
- 7. Check the model number of the Packet Engine. The model number is located in the upper right corner of the Packet Engine.
- 8. If the Packet Engine model number is 7101-01 or 7101-02, insert the Packet Accelerator shunt jumper (JP1801) by removing the jumper from the single pin it covers and place it over both pins. See Figure 5.5 for the position of the shunt jumper

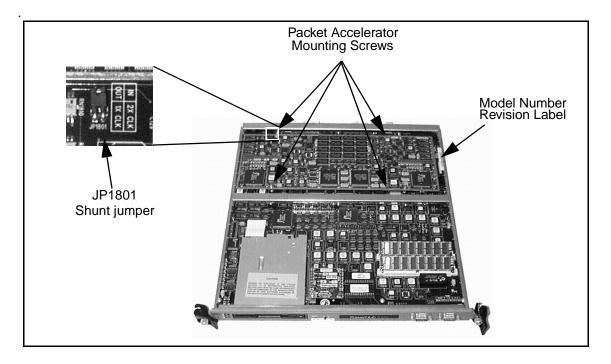


Figure 5.5 - Packet Engine Components

- 9. Install the PE into the chassis following the procedure in Section 5.1.1.
- 10. When the PE and any other removed NIMs have been installed, power on the unit and watch the boot messages for a line similar to the one shown below in bold type. If this line is present and shows the Packet Accelerator was installed, the installation was successful.

```
Looking for packet accelerator card
1 2
Found packet accelerator - will use 4MB shared memory
Packet accelerator IOPs will be used
```

5.2.2.2 Removing a Packet Accelerator

The following procedure describes how to remove a Packet Accelerator from the PE. Refer to Figure 5.2 for the location of the Packet Accelerator and the screws securing it to the PE.

- 1. Follow the procedure in Section 5.1.2 to remove the PE from the chassis.
- 2. Remove the mounting screws securing the Packet Accelerator to the PE as shown in Figure 5.2.

- 3. Gently pull up on the Packet Accelerator to free the pin headers from the pin sockets on the PE. If the module does not lift freely, gently rock it from side-to-side to loosen the pins.
- 4. Place the Packet Accelerator in its protective packaging.
- 5. If not reinstalling a Packet Accelerator, follow the procedure in Section 5.1.1 to reinstall the PE.

5.2.3 Media Adapters

This section provides procedures to install or remove media adapters supported by the PowerCell 700 ATM Module. The supported media adapters include:

ATM Media Adapters (AMAs). Refer to Chapter 7, ATM Interfaces, for more information on AMAs.

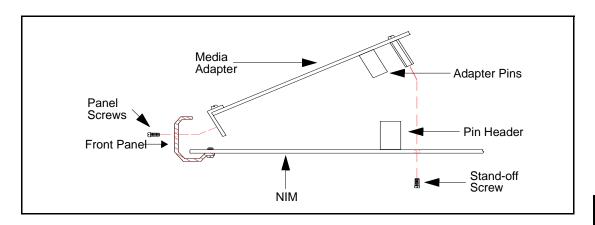


Figure 5.6 - Removing/Installing a Media Adapter

The following media adapters are supported on the modules listed.

Table 5.1 - Media Adapters

PowerCell 700 ATM Module		
	OC-3 (single- or multimode) AMA	
	OC-3 UTP	

5.2.3.1 Installing a Media Adapter

CAUTION



Static electricity can damage the electronic components. Refer to *Chapter 4, Safety and Environmental Requirements* for the appropriate precautions to be taken when handling components.

The following procedure describes how to install a media adapter. The pin sockets contain a plastic border around the pins. This border creates a tight fit for the media adapters when installing them.



When installing the adapters, do not plug any cables into the adapters until the system has completed the booting process.

The following tools are required to install a media adapter:

- #2 Phillips screwdriver
- Medium flat-head screwdriver
- 3/16" hex nutdriver
- A grounded work surface, such as a grounded metal table or a table covered with a grounded, rubberized mat is required if components are to be removed or installed.
- 1. Remove the two screws securing the blank faceplate covering the empty adapter bay to the front of the NIM. Retain the blank faceplate and screws in the event the adapter is later removed.
- 2. While holding the rear of the adapter, gently insert the segment/port connector of the adapter through the opening on the NIM front panel as shown in Figure 5.6. Notice that adapter is installed component-side down.
- 3. Ensure that the segment/port connector is fully forward by pushing on it until it is firmly in place. The front of the adapter must be flush with the back of the front panel.
- 4. Align the adapter pins directly over the pin socket on the NIM.

CAUTION



Visually ensure that the standoffs and their corresponding screw holes, and the connector pins and their corresponding pin sockets are properly aligned. If the pins and sockets are not aligned properly, the pins can break and the NIM and/or adapter can be damaged.

5. When the pins are properly aligned over the socket, firmly and evenly press the backside of the adapter down to push the pins into the socket. While pushing down on the adapter, it may be necessary to gently rock it side-to-side to help seat the pins into the socket.

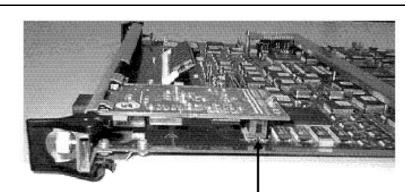
CAUTION



When seating the adapter, check the sides of the pin socket for pins that are protruding. If increased resistance is felt when seating the adapter or if pins are protruding from the side of the pin socket, stop seating the adapter, and remove it.

Repeat step 5 to attempt to seat the adapter. If the module still does not seat properly, call FORE Systems TAC.

When the adapter is properly seated, it should appear as shown in Figure 5.7.



Ensure that all pins are correctly aligned and seated in the pin socket.

Figure 5.7 - Media Adapter Alignment

6. To secure the adapter to the NIM, insert and tighten the screw on the underside of the NIM.

CAUTION



Be sure to use the screws provided with the adapter. Use of screws other than those provided may result in damage to the adapter or the NIM.

- 7. Re- insert the NIM into the ASN-9000, securing the thumbscrews.
- 8. If no more adapters are to be removed from this NIM, use the procedure in Section 5.1.1 to reinstall the NIM.
- 9. Reboot the system to activate the changed system configuration.

5.2.3.2 Removing a Media Adapter

CAUTION



Static electricity can damage the electronic components. Refer to *Chapter 4, Safety and Environmental Requirements* for the appropriate precautions to be taken when handling components.

The following procedure describes how to remove a media adapter from a ASN-9000 NIM. The pin sockets on some NIMs contain a plastic border around the pins. This border creates a tight fit for the media adapters when removing them. The following tools are required to remove a media adapter:

The following tools are required to remove a media adapter:

- #2 Phillips screwdriver
- Medium flat-head screwdriver
- 3/16" hex nutdriver
- · Regular flat-head screwdriver
- ESD wrist-strap
- A grounded work surface, such as a grounded metal table or a table covered with a grounded, rubberized mat is required if components are to be removed or installed.

• If the removed Media Adapter is not to be replaced, replace the appropriate cover plate.

Figure 5.6 shows how a Media Adapter is removed from a module.

1. Use the procedures in Section 5.1.2 to remove the NIM containing the media adapter to be removed from the chassis.

CAUTION



Never attempt to add, remove, or modify components on a Packet Engine or NIM when the module is still in the chassis. Components can break or be damaged by electrostatic discharge, or the module itself may crack as a result of improper handling.

- 2. Remove the screw and washer securing the adapter to the NIM. These are located on the underside of the NIM. Do not remove the standoff on the adapter itself.
- 3. Remove the two pan-head screws securing the adapter to the NIM front panel.
- 4. Grasp the rear of the adapter, making sure not to grab the pin connections. (These can become bent and damage the adapter.)
- 5. Gently pull up on the rear of the adapter to loosen the pins from the socket on the NIM. If the pins do not come loose, gently rock the rear of the adapter from side to side while pulling up. Stop pulling as soon as the pins come loose to prevent damaging the adapter.
- 6. When the adapter pins are free from the socket on the NIM, gently pull the adapter straight out of the NIM front panel. If the adapter gets caught, gently jiggle it free. Do not force the adapter to come free to prevent damaging components.
- 7. When the adapter is completely free of the NIM, either place it in its protective container for storage or, if planning on installing it in another NIM, place it on a grounded table.
- 8. If the adapter is not to be replaced with another adapter, install the appropriate cover plate over the unused adapter position.
- 9. If no more adapters are to be removed from this NIM, use the procedure in Section 5.1.1 to reinstall the NIM.
- 10. Reboot the system to activate the changed system configuration.

5.2.4 Changing the Setting of the Lock Switch Jumper

The PE has two hardware mechanisms to restrict access to the ASN-9000; the Lock/Unlock Switch and Lock/Unlock Jumpers.

Both the Lock/Unlock Switch and the Lock/Unlock Jumpers are located on the PE. The Lock/Unlock Switch is located on the front panel and the Lock/Unlock Jumpers are located on the circuit board. The Lock/Unlock Jumpers are inaccessible without removing the PE from the chassis.

When the Lock/Unlock Switch is set on (L) a userid and password are required to access the ASN-9000. When set to off (U), no userid or password is required and anyone can access the ASN-9000 through the TTY1/TTY2 ports or a Telnet session.

The Lock/Unlock Jumper has LOCK and UNLOCK jumper positions to override either position of the switch. A third position 'SPARE' can be used as a storage position if the Lock/Unlock Switch is to control access to the ASN-9000. If the jumper is set to Lock or Unlock, changing the position of the Lock/Unlock Switch has no effect on the operation of the ASN-9000.

The following procedure describes how to set the Lock/Unlock Jumper. Refer to Figure 5.2 for the location of the Lock/Unlock Jumpers on the PE.

CAUTION



Never attempt to add, remove or modify components on a Packet Engine or NIM when the module is installed in the chassis. Components can become broken or damaged through electrostatic discharge, or the module itself can become cracked through improper handling.

- 1. Follow the procedure in Section 5.1.2 to remove the PE1 from the chassis.
- 2. Locate the Lock/Unlock Jumpers. Figure 5.8 shows a close-up of the Lock/unlock Jumpers on the PE.
- To set the Lock Switch Jumper, disabling the front panel Lock/Unlock Switch forcing restricted access, remove the jumper from the UNLOCK or SPARE pin headers and place it across the LOCK pin headers.
- 4. To set the Unlock Switch Jumper, disabling the front panel Lock/Unlock Switch allowing unrestricted access to the ASN-9000, remove the jumper from the LOCK or SPARE pin headers and place it across the UNLOCK pin headers.

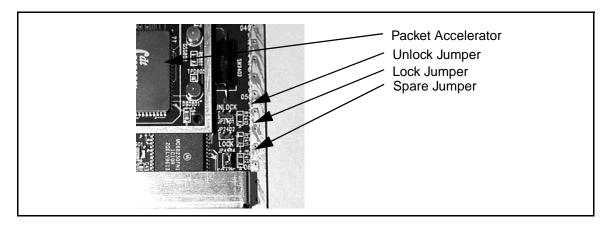


Figure 5.8 - Lock/Unlock Jumpers

5. To disable the Lock/Unlock Switch Jumper, enabling the front panel Lock/Unlock Switch, remove the jumper from the UNLOCK or LOCK pin headers and place it across the SPARE pin headers.

5.2.5 Replacing a Power Module

Power modules can be installed at any time, even while the hub is operating. If the chassis contains only one power module, always install the power module in the primary bay. If the chassis contains more than one power module, one of the modules must be installed in the primary bay. The primary power module bay is the upper-left bay

A #2 Phillips-head screwdriver is required to replace a failed power module.

To replace a failed power module:

- 1. Turn the power switch to the OFF position (marked \mathbf{O}).
- 2. Loosen the two thumbscrews on the power module to be replaced. The thumbscrews should disengage from the chassis, but not from the power module.
- 3. Gently pull the power module from the power module bay, keeping the power supply level to avoid damaging any NIMs in the slot above the power supply bay.



If a new power module is being installed in a power module bay that is currently empty and is covered by a protective cover plate, remove the two screws from the cover plate. Remove the cover plate. Do not place the plate or screws inside the power module bay.

- 4. Place the rear of the power module into the empty power-module bay, keeping the power module level. Tilting the power module upward may contact the NIM in the slot above it and damage the NIM.
- 5. Gently slide the power module all the way into the bay. Do not force the power module into place. If it does not slide easily into place, remove it and try again.
- 6. When the power module is fully in place, firmly tighten the thumbscrews.
- 7. Plug the power cable into the receptacle on the front of the power module.
- 8. Plug the other end of the cable into the appropriate 110-volt or 220-volt AC circuit or 40–60-volt DC power source. If installing a DC power module, connect the cable to the power source as follows:

Black wires -48-volt.
 Red wires +48-volt.
 Green wires Ground.

WARNING!



For the DC power module, connect the wires as described above. If the wires are connected differently and power is applied, the power module and the ASN-9000 might be damaged. Damage caused by incorrect wiring is not covered by warranty.

9. Turn the power switch to the ON position (marked |).

Provided a "load" is present in the chassis (at least a Packet Engine), the power module begins supplying current as soon as the power switch is turned on. (The power module does not activate if no load is present.) All three LEDs on the power module's front panel light up. If any of these LEDs fails to light up, check the power connections and try again. If the problem persists, contact FORE Systems TAC.

CHAPTER 6

Boot PROM Commands

The ASN-9000 supports Boot PROM commands controlled from the Packet Engine firmware to manage and store files, view the configured Ethernet address, set or unset Non-Volatile Random Access Memory (nvram) boot order variables, and boot the system from either the default device or to designate a different boot source. The Boot PROM prompt is not accessible during normal runtime operation, but is displayed if the boot process is interrupted or if an error occurs during the boot sequence. The Boot PROM command prompt is displayed as <PROM-9PE>.

The Boot PROM commands are available to the user if the normal boot process is aborted at the 5-second delay prompt. A typical ASN-9000 boot screen display is shown in Figure 6.1.

```
Starting Packet Engine ...
Prom version: pelp-3.0.0 (7887) 1998.05.06 13:01
I-cache 16KB OK
Entering cached code
I-cache execution OK
D-cache 4KB OK
SRAM 128KB OK
DRAM 24MB OK
Shared Memory 4MB OK
Entering Monitor
FORE Systems ASN-9000
FlashInit: found 4MB Flash Memory Module
Board Type: 9PE , CpuType: MCPU, Instance: 1
Ethernet address: 00-00-ef-03-9a-b0
(normal start)
Hit any key now to abort boot [4]:
<PROM-9PE>
```

Figure 6.1 - ASN-9000 Boot Screen Display

The display below shows the available Boot PROM commands that the user would normally access:

```
<PROM-9PE> ?
COMMANDS:
                       boot|b [-n] [fd|net|fm]
                       copy|cp <src-file> <dest-file>
       copy file:
                       -or-
                        copy cp <src-file> [<src-file>...] <device>
       ethaddr:
                       ethaddr | ea
       help:
                       help ? [COMMAND]
       expert help:
                       ??
       ls:
                       ls|dir
       more:
                       more [-[<rows>]] f1 [f2...[fn]]
       nvram:
                       nvram [set|unset|show <variable> [<value>]]
                       ("nvram set bo" sets disk/net boot order)
       remove file:
                      rm|del [-f] f1 [f2...[fn]]
       rename file: rename | ren <oldfilename > <newfilename >
       zmodem receive: zreceive|zr|rz [-+27abcehtw] [<filename>]
       zmodem send:
                       zsend|zs|sz [-+27abehkLlNnoptwXYy]
<PROM-9PE>
```

Additional commands are available under expert help, accessed by entering two question marks (??). Most of the commands located under expert help should be used only as directed by FORE Systems TAC. Some of the commands are used when upgrading the Packet Engine firmware. Those commands the user is expected to use in the normal operation of the ASN-9000 are discussed in this chapter. Those commands which should be reserved for FORE Systems TAC use are not discussed. The complete set of Boot PROM commands are listed in the display below:

```
<PROM-9PE> ??
COMMANDS:
                        boot | b [-n] [fd | net | fm]
       bootdef parser ver:
                                         bpv
       breakpoint: brk | bp [ADDRLIST]
       cacheflush:
                       cacheflush cf [-i|-d]
       call:
                       call ca ADDR [ARGLIST]
                        compare | cmp [ <-w | -h | -b > ] RANGE dest
       compare:
       continue:
                        cont | c
       copy file:
                        copy cp <src-file> <dest-file>
                        -or-
                        copy cp <src-file> [<src-file>...] <device>
       date:
                        date [YYMMDDhhmm[.ss]]
                        dbgint | di [<-e|-d> <DEV>]
       debug int.:
       debug (remote) debug | db [SERIAL PORT]
       disassemble:
                        dis RANGE
       dump regs:
                        dr [<reg#|reg_name>]
                       dump d [-w |-h |-b] RANGE
       dump:
       dumpw:
                       dumpw ADDR
       ethaddr:
                        ethaddr|ea
       fill:
                        fill|f[<-w|-h|-b|-l|-r>] RANGE [<value_list>]
```

```
fill:
                      fillword fw <word-address> <value>
       fill regs:
                      fr <reg#|reg_name><value>
                      go INITIAL_PC
                     gotill|gt <brk addr>
       go until:
       help:
                    help ? [COMMAND]
       expert help:
                      history|h
       history:
       iop test:
                      iop
                      load | [-b] fd-filename | tty0 | tty1
       load:
       ls:
                      ls|dir
       more:
                      more [-[<rows>]] f1 [f2...[fn]]
                      next n [COUNT]
       next:
                    nvram [set|unset|show <variable> [<value>]]
       nvram:
                      ("nvram set bo" sets disk/net boot order)
       radix select: rad [<-o|-d|-h>]
       reg set select: regsel|rs [<-c|-h>]
       remove file: rm | del [-f] f1 [f2...[fn]]
       rename file: rename | ren <oldfilename > <newfilename >
       setbaud:
                    setbaud|sb ttyl <baud rate>
       search:
                    search|sr [<-w|-h|-b>] RANGE value [mask]
       select seg.: seg [<-0|-1|-2|-u>]
                     step|s [COUNT]
       temperature: temperature | temp
       unbrk: unbrk|ub [BPNUMLIST]
       version:
                      ver
       Write Cache: wc [-i][-w|h|b] < RANGE > < valuelist >
       Read Cache: rc [-i][-w|h|b] <RANGE>
       zmodem receive: zreceive|zr|rz [-+27abcehtw] [<filename>]
       zmodem send: zsend|zs|sz [-+27abehkLlNnoptwXYy]
COMMAND LINE OPTIONS:
       Memory reference options:
              -b=byte, -h=halfword, -w=word(default)
              -l=unaligned left, -r=unaligned right
       Note: If no radix is specified, the default radix is used.
              One exception - COUNTS are ALWAYS DECIMAL
       RANGE's are specified as one of:
              BASE ADDRESS/COUNT or START ADDRESS-END ADDRESS
       If less than a 32 bit address is specified
       the DEFAULT SEGMENT is or'ed into the address
       Erase single characters by CTRL-H or DEL
       Rubout entire line by CTRL-U
```

Notice the last two lines of the expert help display, above. These control-key sequences can be used to erase characters in a command line entry or the entire command entry. These control-key sequences may be affected by the terminal emulation being used to interface the ASN-9000.

Table 6.1 lists the commands that would normally be used in the Boot PROM user interface. In some instances, additional syntax has been added to reflect the actual syntax of the respective command. Some of the Boot PROM commands have similar or identical commands available under the normal operating system user interface (UI). Those commands contain a reference to the respective chapter of this manual. Commands that should only be used under FORE Systems TAC direction are not listed.

Table 6.1 - Boot PROM Commands

Command	Description
boot b [-n] [fd net fm]	Boots the system, using the device(s) specified in nvram as the boot source. Equivalent to system reboot.
<pre>copy cp [<device>] <src- file=""> <dest-file> -or- [<device>] <src-file> [<src-file>] <device></device></src-file></src-file></device></dest-file></src-></device></pre>	Copies a file, or files to or from either a floppy diskette (fd:) or Flash Memory Module (fm:) of the ASN-9000 Equivalent to global help copy cp.
date [YYMMDDhhmm[.ss]]	Sets or displays the current date and time. Equivalent to system date.
ethaddr ea	Displays the MAC-layer hardware address. Equivalent to system ethaddr ea.
go INITIAL_PC	Used in conjunction with the <code>load 1</code> command. After loading a file, the <code>go</code> command causes the loaded file to be executed. An initial program count (<code>INITIAL_PC</code>) can be specified if the loaded executable did not set an initial program count start point.
help ? [COMMAND]	Displays the commands available at the Boot PROM prompt. Equivalent to global help ?.
??	Displays all commands that are available at the Boot PROM prompt, including commands that are intended for use by FORE Systems TAC only. Equivalent to global help.
history hi	Displays a list of the last 16 commands issued at the Boot PROM prompt. Equivalent to global help history hi.
load 1 [-b] fd-file- name tty0 tty1	Loads a file from the default device or a specified device. The specified device could be either a floppy diskette (fd:) or in the Flash Memory Module (fm:) of the ASN-9000.
<pre>ls dir [<device>] [<file- spec=""> [<file-spec>]]</file-spec></file-></device></pre>	Displays a directory of the files on either a floppy diskette (fd:) or Flash Memory Module (fm:) of the ASN-9000. Equivalent to global help ls dir.

Boot PROM
Commands

Table 6.1 - Boot PROM Commands

Command	Description
<pre>more [-<rows>] <file- name=""> [<file-name>]</file-name></file-></rows></pre>	Displays to the terminal screen the contents of a file located on either a floppy diskette (fd:) or in the Flash Memory Module (fm:) of the ASN-9000. Similar to global help type cat.
nvram [set unset show]	Sets, removes or displays nvram settings. Equivalent to commands in the nvram subsystem.
<pre>rm del [<device>] [-f] f1 [f2[fn]]</device></pre>	Deletes a file, or files, from the default or specified device. The floppy diskette (fd:) or the Flash Memory Module (fm:) of the ASN-9000. Equivalent to global help rm.
<pre>rename ren [<device>] <oldfilename> [<device>] <newfilename></newfilename></device></oldfilename></device></pre>	Renames a file on the default or specified device a floppy diskette (fd:) or in the Flash Memory Module (fm:) of the ASN-9000. Equivalent to global help rename mv.
<pre>setbaud sb tty1 <baud rate=""></baud></pre>	Sets the TTY1 baud rate. Equivalent to global help stty <speed>.</speed>
temperature temp	Displays the temperature of the PE. Equivalent to system temperature temp.
ver	Displays the version number of the current PE firmware. Equivalent to system version ver.
<pre>zreceive zr rz [- +27abcehtw] [<device>] [<file-name>]</file-name></device></pre>	Uploads a file from a PC or Macintosh that supports the ZMODEM or XMODEM protocol onto a floppy diskette (fd:) or in the Flash Memory Module (fm:) of the ASN-9000 via either the TTY1 or TTY2 terminal console ports.
<pre>zsend zs sz [- +27abehkLlNnoptwXYy] [<device>] [<file-name>]</file-name></device></pre>	Downloads a file to a PC or Macintosh that supports the ZMODEM or YMODEM protocols via either the TTY1 or TTY2 terminal console ports.

6.1 Booting the System Software

The system software can be loaded using any of the following methods:



Configuration changes made since the last time the software was loaded should be saved using the system savecfg command before performing a cold reboot. For information on the savecfg command, refer to ForeRunner ASN-9000 Software Reference Manual.

- Pressing the reset switch (labeled RST), on the front of the Packet Engine.
- Turning off, then on, the power supplies.
- Issuing the system reboot command from any system level command prompt.
- Issuing the boot command from the boot PROM command prompt.

For detailed information on the software systems, refer to the *ForeRunner ASN-9000 Software Reference Manual*.

6.1.1 Displaying the Packet Engine Boot PROM

When rebooting or resetting the system, a power-on self-test is performed before the software is loaded. When the power-on self-test is complete, and before the software is loaded, the following message is displayed:

```
Hit any key now to abort boot [3]:
```

The ASN-9000 counts down for five seconds before it resumes the boot sequence. The ASN-9000 attempts to boot from the boot sources in the order specified by the nvram bo command. If no boot order was set, the ASN-9000 attempts to boot in the order specified in Section 6.2.1. If a key is pressed during the countdown, the ASN-9000 aborts the boot sequence and the boot PROM prompt is re-displayed.

Boot PROM

6.1.2 Reset Switch

The reset switch is located on the Packet Engine front panel and is labeled RST. When the reset switch is pressed, the Packet Engine performs a "cold" restart. During a cold restart, the Packet Engine conducts a power-on self-test to check its various hardware components.

Depending on the boot preference(s) specified with the nvram command, the Packet Engine loads the appropriate files that are located in default-device or on a TFTP server (network booting) to configure the ASN-9000 for runtime operation.

6.1.3 Turning the Power Modules Off and On

Turning the power modules off and then on again, also causes the ASN-9000 to perform a cold restart.



If there is more than one power module installed in the chassis, turn all power modules off and then on, simultaneously.

6.1.4 Using the Reboot Command

To reboot the system from a runtime command prompt, issue the reboot command from the system subsystem or enter system reboot from within any subsystem. Entering reboot displays the following messages on the console:

```
66:ASN-9000:system# reboot
```

```
FORE Systems ForeRunner ASN-9000 Packet Engine
Prom version: pelp-3.0.0 (7887) 1998.05.06 13:01
I-cache 16KB OK
Entering cached code
I-cache execution OK
D-cache 4KB OK
SRAM 128KB OK
DRAM 24MB OK
Shared Memory 4MB OK
Entering Monitor
FlashInit: found 4MB Flash Memory Module
Board Type: 7PE , CpuType: MCPU, Instance: 1
Ethernet address: 00-00-ef-03-9a-b0
(normal start)
Hit any key now to abort boot [5]:
<PROM-9PE>
```

6.2 Boot PROM Commands

The following sections explain how to use the Boot PROM commands. The Boot PROM commands are displayed by issuing the help command from a Boot PROM prompt. Refer to Section 6.2.4 for a description of the help command.

WARNING!



Execution of the additional commands listed under expert help are for FORE Systems Technical Assistance Center (TAC) use only. Users are cautioned not to execute any of the commands listed under the expert help command.

6.2.1 Boot

To reboot the system from a boot PROM prompt, issue the boot | b command. The syntax for the boot command is:

boot|b [-n] [net|fd|fm]

where

 Instructs the Packet Engine not to start runtime execution. Only the Packet Engine image () is loaded and the boot sequence is then automatically aborted.

fd Boots the software from the floppy diskette.

fm Boots the software from the Flash Memory Module.

.

If a boot source is not specified, the boot order configured in NVRAM is used.



The Packet Engine software image (PE1) must be present on the boot source specified. The boot command does not affect the boot order specified in NVRAM. (Refer to the *ForeRunner ASN-9000 Software Reference Manual* for information on setting the boot order in the NVRAM.)

6.2.2 Copy

To copy a file, or files, from the default device (Floppy Disk or Flash Memory Module) issue the copy file (copy | cp) command.

copy|cp [default-device|<device>]<src-file> <dest-file>

where

[default-device|<device>] Specifies the source/destination device. If no device

is specified, the default-device is used.

<src-file> Specifies the file name of the source file to be copied.

<dest-file> Specifies the destination file name.

6.2.3 Ethernet Address

Each Packet Engine contains a unique MAC-layer hardware address. This address is assigned at the factory and identifies the Packet Engine and by extension the chassis containing the Packet Engine. A label on the front panel of the Packet Engine displays the assigned MAC address. The MAC address is also displayed in boot messages. The ethaddr command can be used to display the MAC-layer hardware address of the Packet Engine. The ethaddr command displays the following information:

<PROM-9PE> ethaddr Ethernet address: 00-00-ef-03-9a-b0 <PROM-9PE>



6.2.4 Help

Help is available from the Boot PROM prompt by issuing the help|?|h command. Additional help is available for the commands listed by entering help|?|h [command]. The syntax for the help command is:

help|?|h

Issuing help | ? | h from the boot PROM prompt displays the following screen.

```
COMMANDS:
       boot:
                       boot | b [-n] [fd | net | fm]
       copy file: copy|cp <src-file> <dest-file>
                               -or-
                               copy|cp <src-file> [<src-file>...] <device>
       ethaddr:
                     ethaddr|ea
       help:
                     help ? [COMMAND]
       expert help: ??
                     ls|dir
       ls:
       more:
                     more [-[<rows>]] f1 [f2...[fn]]
               nvram [set|unset|show <variable> [<value>]]
       nvram:
                               ("nvram set bo" sets disk/net boot order)
       remove file: rm | del [-f] f1 [f2...[fn]]
       rename file: rename | ren <oldfilename > <newfilename >
       zmodem receive: zreceive|zr|rz [-+27abcehtw] [<filename>]
       zmodem send: zsend|zs|sz [-+27abehkLlNnoptwXYy]
<PROM-9PE>
```

6.2.5 Expert Help

The command listed under expert help are for use by FORE Systems Technical Assistance Center (TAC) only. These commands are designed to aid TAC in diagnosing and troubleshooting the Packet Engine in the event of failure. Users are cautioned not to attempt execution of any of the help commands listed under expert help that are not listed under the help display.

Soot PROM

6.2.6 Directory

The ls and dir commands display a directory of the files on the default-device. The default-device when at the Boot PROM prompt on a ASN-9000 is the Floppy Diskette. On the ASN-9000 files can also be viewed from the Flash Memory module by preceding the filespec with fm:. Each command displays the volume name and the files contained on the volume. The ls and dir commands display a DOS-like format, including the amount of free space on the volume. These commands differ from the system ls | dir commands in that all files on the specified device are listed. The system ls | dir commands allow entering a filespec option to filter specific files to be displayed. The syntax for the ls | dir commands is:

```
ls|dir <filespec>
```

where

<filespec> Limits the display to those files meeting *< filespec>*.

The display below shows an example of the use of the ls command listing the files located in the Flash Memory module:

6.2.7 More

The more command can be used to display a file located on any available device. The syntax for this command is:

```
where
    -[<rows>]] [<device>]f1 [f2...[fn]]

where
    -<rows> Specifies how many rows of the file are to be displayed at a time.

f1 [f2...[fn]] Specifies a file, or files, to be displayed to the operator console.
```

6.2.8 NVRAM

The nvram command is used to set, unset or show initial nvram parameters. The syntax for the nvram command is:

nvram [set | unset | show <variable > [<value >]]

where

set|unset|show Specifies whether to set, unset, or show the nvram

variables and/or values specified.

<variable> Specifies which nvram variable to set. The available

options are:

bo boot order
myip local IP address
mysm local subnet mask
fsip file server address
gwip boot gateway address
crashreboot post-crash behavior

slotsegs[n] reserve < num > segments in slot [n]

<value> Specifies the value for the respective <variable>

above. The IP address is entered in dotted decimal notation, crashreboot is a boolean value and slotsegs

is the number of segments allocated to [n] slot.



A valid configuration file must be present on the designated netboot device before booting off the network device can occur.

6.2.9 Remove File

To remove a file or files on the default-device, issue the remove file (rm|de1) command. The default-device is the floppy disk on an ASN-9000 . On the ASN-9000 files can also be viewed from the Flash Memory module by preceding the filespec with fm:

rm | del [-f] f1 [f2...[fn]]

where

-f Specifies to use non-interactive mode ("force" deletions). If the -f option is not used, the system responds with remove filename? and the user is required to respond with either 'y' (yes) or 'n' (no) to proceed.

f1 [f2...[fn]] Specifies the file, or file list, of files to be removed from the default device.

6.2.10 Rename File

To rename a file on the default-device, issue the rename file (rm|del) command. The default-device is the floppy disk on an ASN-9000. On the ASN-9000 files can also be renamed from the Flash Memory module by preceding the filespec with fm:.

rename | ren <oldfilename> <newfilename>

where

 <oldfilename> Specifies the name of the original file.

<newfilename> Specifies the name of the new file.

6.3 Uploading/Downloading Files

This section describes the ZMODEM support available from the Boot PROM command line. The two ZMODEM commands, **zreceive** and **zsend**, are discussed, as well as procedures to configure the ASN-9000 to utilize these commands.

The ASN-9000 supports ZMODEM file transfer protocol. Using the ZMODEM commands, files can be copied between the ASN-9000 and a PC or Macintosh running a ZMODEM protocol application. Files transferred using these commands are sent or received to or from the ASN-9000 default-device. The default-device on an ASN-9000 is the floppy disk. If the PC or Macintosh supports XMODEM, the ZMODEM commands can be used to perform XMODEM transfers. To use the ZMODEM commands, a PC or Macintosh supporting ZMODEM must be connected to TTY1 or TTY2:

- If the management terminal on TTY1 contains the ZMODEM or XMODEM application, ASN-9000 commands can be issued to set up the transfer, then switch to the ZMODEM or XMODEM application to activate the transfer.
- Alternatively, the transfer can be set up from the management terminal on TTY1, then use the ZMODEM or XMODEM application on the device connected to TTY2 to complete the transfer.

6.3.1 ZMODEM Receive

The **zreceive** command prepares the ASN-9000 to receive a file. After issuing the **zreceive** command, the ZMODEM or XMODEM application on the PC or Macintosh must be used to actually begin the transfer.

The **zreceive** command provides numerous options, but the defaults for those options are appropriate for most file transfers. The defaults are the same for XMODEM transfers, except that a file name must be specified. File names are not necessary when performing a ZMODEM transfer. The syntax for the **zreceive** command is:

zreceive|zr|rz [-+27abcehtw] [<filename>]

where

- Introduces the argument list. If any arguments are specified, the argument list must be preceded by the (hyphen). If arguments are not specified, do not use the (hyphen).
- + Causes the file being received to be appended to an already existing file. Specify the file name at the end of the argument list (ex: zr -+ae hub1.log).

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- 2 Causes the file transfer to take place through the TTY2 port, rather than the TTY1 port. By default, the transfer takes place over the TTY1 port.
- 7 Uses 7-bit bytes for the transfer. By default the ZMODEM program uses 8-bit bytes.
- a Performs the transfer in ASCII mode, using the appropriate newline translation. By default, the transfer takes place in binary mode.
- **b** Performs the transfer in binary mode. Binary is the default transfer mode.
- c XMODEM only. Uses a 16-bit CRC.
- e Ignores control characters.
- h Sets the serial baud rate to 19.2 Kpbs.
- t Sets the receive time-out to N/10 seconds ($10 \le N \le 1000$). Specify the file name at the end of the argument list (ex: zr -at 500). The default is 100; that is, 10 seconds.
- w Sets the protocol window to N bytes. Specify the file name at the end of the argument list (ex: zr -aw 10).

<filename>

Entering a filename causes the XMODEM protocol to be used. If using ZMODEM protocol it is not necessary to specify a file name. The ASN-9000 assumes the file is to be written to the floppy disk, for an ASN-9000.



The **zreceive** command only transfers files to the default-device, floppy disk on the ASN-9000. Use the **copy** | **cp** command to transfer the file(s) to the Flash Memory module.

If a filename is not specified, or none of the optional arguments are specified, the ASN-9000 uses the ZMODEM protocol to receive the file on TTY1, in binary mode, using 8-bit bytes. When the **zr** command is executed on the ASN-9000, the ZMODEM application on the PC or Macintosh must be used to specify the file to be transferred and to perform the transfer.

Following are some examples of the use of the **zreceive** command. After issuing the command on the ASN-9000, use the appropriate protocol application on the PC or Macintosh to transfer the file.

In the first example, ZMODEM is used to prepare the ASN-9000 to receive a binary file from a PC or Macintosh. All defaults are used. Notice that no file name is specified. When using ZMODEM, specify the file name on the PC or Macintosh.

```
<PROM 7PE> zreceive
```

In the following example, the ASN-9000 is prepared to receive a configuration file from a PC or Macintosh. All defaults are accepted, except the default for transfer mode. The **a** argument is used to change the transfer mode to ASCII, which is appropriate for ASN-9000 configuration, environment, and boot definition files. Notice that the hyphen (-) is used to introduce the argument list.

```
<PROM 7PE> zreceive -a
```

The following example shows how the ASN-9000 is prepared to upload a file using XMO-DEM. Because, XMODEM, unlike ZMODEM, does not send filenames from the sending device, the receiving device (the ASN-9000 in this case) must supply the file name.

```
PROM 9PE> zreceive 9pe
```

In the following example, ZMODEM is used to prepare the ASN-9000 to upload an ASCII file from the PC or Macintosh connected to TTY2. The t argument is used to specify the receive time-out. Notice that the receive time-out is specified after the argument list.

```
<PROM 9PE> zreceive -2a 10
```

If XMODEM were used instead of ZMODEM, the file name would follow the value 10, as shown in the following example.

```
<PROM 7PE> zreceive -2a 10 monitor.env
```

6.3.2 ZMODEM Send

The zsend command is used to download a file from the ASN-9000 to a PC or Macintosh. This command can be used to perform transfers to devices supporting ZMODEM or YMODEM. Like the zreceive command, the zsend command provides many options, but the defaults for these options are appropriate for most transfers. The syntax for this command is:

zsend|zs|sz [-+27abehkLlNnoptwXYy]

where

 Introduces the argument list. If any arguments are specified, the argument list must be preceded by a -(hyphen). If arguments are not to be used, do not specify the - (hyphen).

- + ZMODEM only. Causes the file to be appended to an existing file. Specify the file name at the end of the argument list (ex: zs -+a hub2.log).
- 2 Causes the file transfer to take place through the TTY2 port, rather than the TTY1 port. By default, the transfer takes place over the TTY1 port.
- 7 Uses 7-bit bytes for the transfer. By default the ZMODEM program uses 8-bit bytes.
- a Performs the transfer in ASCII mode, using the appropriate newline translation. By default, the transfer takes place in binary mode.
- **b** Performs the transfer in binary mode. Binary is the default transfer mode.
- e ZMODEM only. Escapes all control characters.
- h Sets the port baud rate to 19.2 Kpbs.
- k YMODEM only. Transfers the file in 1024-byte packets.
- L ZMODEM only. Limits the subpacket length to N bytes. Specify the file name at the end of the argument list (ex: zs -al 64).
- I ZMODEM only. Limits the frame length to N bytes (l>=L). Specify the file name at the end of the argument list (ex: zs -al 64).
- N ZMODEM only. Transfers the file only if the version on the ASN-9000 is both newer and longer than the version on the PC or Macintosh. Otherwise, the file is not transferred.
- n ZMODEM only. Similar to N, except the file is transferred if it is newer, even if it is not longer than the identically named file on the PC or Macintosh.
- ZMODEM only. Uses 16-bit CRC rather than the default 32-bit CRC.
- p ZMODEM only. Protects the file specified by *<file-name>* if it already exists on the PC or Macintosh. If the file is already present on the device, it is not overwritten by the file on the ASN-9000.

- t Sets the receive time-out to N/10 seconds ($10 \le N$ ≤ 1000). Specify the filename at the end of the argument list (ex: zs -at 500). The default is 600 (60 seconds).
- w ZMODEM only. Sets the protocol window to N bytes. Specify the filename at the end of the argument list (ex: zs -aw 10).
- X Uses the XMODEM protocol, rather than the ZMODEM protocol. Note that some of the other arguments are not valid with the ZMODEM protocol.
- Y ZMODEM only. Overwrites the file specified by *<file-name>*, but skips the file altogether if the file is not present on the PC or Macintosh. If the file specified by *<file-name>* is not already present on the PC or Macintosh, the file is not written to that device.
- y ZMODEM only. Overwrites the file specified by *<file-name>*. Unlike Y, the y argument does not skip the file if it is not on the PC or Macintosh. Even if the file is not on the device, the ASN-9000 writes the file to the device.

Following are some examples of the use of the zsend command. The first example uses ZMO-DEM to send a software image file from the PC or Macintosh. All the zsend defaults are used.

<PROM-9PE> zsend fore/images/9pe

In the following example, an environment file is sent to the PC or Macintosh connected to TTY1. The ${\bf a}$ argument is used to change the transfer mode to ASCII, which is appropriate for ASN-9000 configuration, environment, and boot definition files. In addition, the ${\bf N}$ argument is used to ensure that the file is transferred only if it is newer and longer than the identically named file on the PC or Macintosh. Notice that the hyphen (-) is used to introduce the argument list and no spaces separate the arguments in the list. A space does separate the file name from the argument list.

<PROM 7PE> zsend -aM root.env

CHAPTER 7 ATM Interfaces

Asynchronous Transfer Mode (ATM) is a high-performance technology for internetworking. ATM uses fixed-size cells to transport data, whereas current LAN technologies use packets that vary in size.

The ASN-9000 provides ATM connectivity through the PowerCell 700 ATM Module and ATM Media Adapters (AMAs). This chapter describes the PowerCell hardware features including the following ATM Media Adapters:

- OC-3 (Single-mode and Multimode)
- **UTP**

7.1 PowerCell ATM Module

The PowerCell 700 is an Intelligent Network Interface Module (INIM) that contains on-board CPUs to handle packet processing so that the Packet Engine resources are not consumed when a cell is received or transmitted on a segment. The PowerCell module contains the ATM physical layer (PHY) and ATM Segmentation and Reassembly (SAR) layers and can support up to 32 logical segments.

The PowerCell module is interoperable with all FORE Systems' ATM switches and can also be used with other vendors' ATM switches provided those switches conform to the ATM Forum standards that the PowerCell module supports. For example, other vendors' equipment must support the ATM Forum standards for LAN Emulation (LANE) 1.0 or 2.0 and User-Network Interface (UNI) 3.0 or 3.1 if it is to be used with the FORE Systems PowerCell module in a LANE 1.0 network.

Some PowerCell modules allow redundant connections to the ATM switch. The redundant connection is provided by a redundant port (PHY) that automatically takes over if the connection to the primary port (PHY) fails.

The FORE Systems PowerCell modules contain the following hardware features:

- AAL5 support.
- Support for up to 155 Mb/s.
- Choice of single-mode or multimode fiber on OC-3 or UTP interfaces.
- Traffic and status LEDs.
- Optional backup PHY that takes over if primary PHY fails.

7.1.1 PowerCell 700

The PowerCell 700 can contain one or two ATM Media Adapters (AMAs). Each AMA provides a single physical port for connection to an ATM switch. The PowerCell 700 can be installed in any available slot and the ASN-9000 can support up to four PowerCell Modules. The PowerCell can be configured to support up to 32 logical segments on each port. Each logical segment can be configured for one of the following protocols:

- LANE (LAN Emulation) 1.0 and 2.0
- RFC-1483 Routed and Bridge Encapsulation
- Classical IP over ATM (RFC 1577)
- FORE IP

Figure 7.1 shows the PowerCell 700 front panel. The PowerCell 700 shown in Figure 7.1 contains both a Primary and Backup AMA.

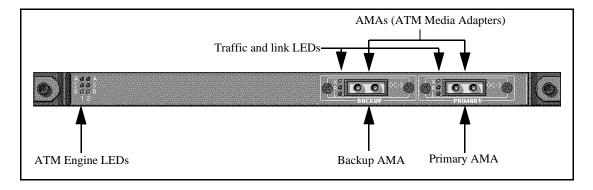


Figure 7.1 - PowerCell 700

The PowerCell 700 contains a single Segmentation and Reassembly (SAR) chip and can contain one or two Physical Layer (PHY) chips. Each PHY is contained in an AMA. The PowerCell 700 can be ordered with a single AMA (primary only) or with two AMAs (primary and backup). If the PowerCell 700 is ordered with only a primary AMA, a second can be installed later as a backup. Section 7.1.1.2 describes the operation of the backup AMA.

The AMA types differ according to the physical interface. The PowerCell 700 AMAs are described in the following sections. Refer to the *ForeRunner ASN-9000 Protocols Reference Manual* for information configuring ATM ports.

7.1.1.1 ATM Engine LEDs

The PowerCell modules contain LEDs that provide a visual status of the ATM Engine, the ATM link and traffic LEDs. (See Figure 7.1.) The PowerCell LEDs are located on the left side of the PowerCell 700. Table 7.1 describes the operation of the PowerCell LEDs.

Label	Color	Indicate the following Condition	
A	Red	Alarm. These LEDs indicate that the PowerCell module has crashed and remain lit until the PowerCell module is rebooted.	
S	Green	The ATM CPUs are functioning normally. If both of these LEDs go out during normal operation, there might be a problem in the ATM Engine. (It is normal for either of the LEDs to be dark sometimes.)	
В	Amber	The PowerCell module is booting. These LEDs flash when the module is booting, then go dark as soon as the module is finished booting.	

Table 7.1 - PowerCell 700 ATM Engine LEDs

7.1.1.2 Backup Port

In a PowerCell module that contains two AMAs, the primary AMA is used for network traffic and the backup automatically takes over if the link on the primary fails. The active-ama | aa command, in the atm subsystem, is used to setup the backup AMA.

The PowerCell 700 allows ports to be installed or removed separately. Therefore, if the Power-Cell 700 contains only one port and a backup port is to be added, an additional port can be installed on the PowerCell 700 module. Refer to *Chapter 5, Installation, Upgrade, and Removal Procedures* for procedures on installing a backup PowerCell AMA.

7.1.2 ATM Media Adapters

The PowerCell module AMAs support OC-3 (single-mode and multimode) and UTP ATM interfaces. The following paragraphs describe each of these AMA interface modules.

7.1.2.1 OC-3 Single-mode and Multimode Fiber AMA

The OC-3 AMA is available in both single-mode and multimode versions and provides bandwidth up to 155 Mb/s. The OC-3 AMA connects to the ATM network using a pair of fiberoptic cables. The type of cable and connectors for the single-mode differs from those for a multimode adapter. Figure 7.2 shows an OC-3 Multimode AMA front panel. The front panel indicates whether it is single-mode (SMF) or multimode (MMF). The function of the front-panel LEDs (X, R, and L) are described in Table 7.2.

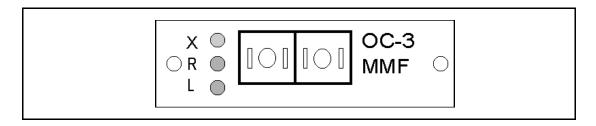


Figure 7.2 - OC-3 Multimode Fiber AMA

7.1.2.2 OC-3 UTP AMA

The OC-3 UTP AMA provides bandwidth up to 155 Mb/s and connects to the ATM network using twisted-pair cable and an RJ-45 connector. Figure 7.3 shows the UTP AMA front panel. The front panel indicates that it is an OC-3 module. The function of the front-panel LEDs (X, R, and L) are described in Table 7.2.

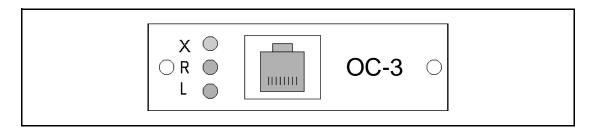


Figure 7.3 - OC-3 UTP AMA

7.1.3 AMA Traffic and Link LEDs

The AMA modules contain front-panel LEDs that provide traffic information and link status for the AMA. Table 7.2 describes the operation of the AMA LEDs.

Table 7.2 - PowerCell Traffic and Link LEDs

Label	Color	Indicates the following Condition	
X	Amber	Transmit. Illuminates during runtime operation. When illuminated, indicates that the PowerCell module is transmitting cells.	
R	Green	Receive. Illuminates during runtime operation. When illuminated, indicates that the PowerCell module is receiving cells.	
L	Green	Link status. Displays the link status for the ATM connection. When glowing the ATM link is "good." The ASN-9000 recognizes an unbroken physical connection to the ATM switch. The link-status LED goes dark if the cable is removed. If the cable is attached but the LED is still dark, the transmit and receive cables may be plugged into the wrong connectors, or a problem might exist in the ATM switch attached to the cable or in the cable itself.	

ATM Interfaces

Acronyms

The networking terms in the following list are defined in the Glossary of this manual. Glossary items are listed alphabetically according to the full term.

AAL ATM Adaptation Layer
ABR Available Bit Rate

ACM Address Complete Message

ACR Allowable Cell Rate

ADPCM Adaptive Differential Pulse Code Modulation

AHFG ATM-attached Host Functional Group

AIMUX ATM Inverse Multiplexing
AIS Alarm Indication Signal
AMI Alternate Mark Inversion
AMI ATM Management Interface

ANSI American National Standards Institute
APCM Adaptive Pulse Code Modulation
API Application Program Interface

APP Application Program

APS Automatic Protection Switching
ARP Address Resolution Protocol

ASCII American Standard Code for Information Interchange

ATDM Asynchronous Time Division Multiplexing

ATM Asynchronous Transfer Mode
AUI Attachment User Interface
BBZS Bipolar 8 Zero Substitution

BCOB Broadband Connection Oriented Bearer

BCOB-A Bearer Class A
BCOB-C Bearer Class C
BCOB-X Bearer Class X

BECN Backward Explicit Congestion Notification

BER Bit Error Rate

BES Bursty Errored SecondsBGP Border Gateway ProtocolB-ISDN Inter-Carrier Interface.

BIP Bit Interleaved Parity

B-ISDN Broadband Integrated Services Digital Network

B-ISUP Broadband ISDN User's Part
BITS Building Integrated Timing Supply

BNC Bayonet-Neill-Concelman

Acronyms

BPDU Bridge Protocol Data Unit

bps Bits per SecondBPV Bipolar Violation

B-TE Broadband Terminal Equipment
BUS Broadcast and Unknown Server
CAC Connection Admission Control
CAS Channel Associated Signaling

CBDS Connectionless Broadband Data Service

CBR Constant Bit Rate

CCITT International Telephone and Telegraph Consultative Committee

CCS Common Channel Signaling

CDV Cell Delay Variation
CE Connection Endpoint

CEI Connection Endpoint Identifier
CES Circuit Emulation Service
CGA Carrier Group Alarm

CIP Carrier Identification Parameter
CIR Committed Information Rate

CLIP Classical IP
CLP Cell Loss Priority
CLR Cell Loss Ratio-1-15
CLS Connectionless service

CMIP Common Management Interface Protocol

CMR Cell Misinsertion Rate

CPE Customer Premise Equipment

CRA Cell Rate Adaptation
CRC Cyclic Redundancy Check

CRS Cell Relay Service
CS Controlled Slip, or
Convergence Sublayer

CSU Channel Service Unit
CTD Cell Transfer Delay
Clear To Send

CTS Clear To Send

DACS Digital Access and Cross-Connect System
DARPA Defense Advanced Research Projects Agency

DCC Data Country Code

DCE Data Communications Equipment
DCS Digital Cross-connect System
DES Destination End Station
DFA DXI Frame Address

DLCI Data Link Connection Identifier

DNS Domain Naming System

DSn Digital Standard n (n=0, 1, 1C, 2, and 3)

DSR Data Set Ready

DTE Data Terminal Equipment **Data Terminal Ready** DTR

EEPROM Electrically Erasable Programmable Read Only Memory

EFCI Explicit Forward Congestion Indication

EGP Exterior Gateway Protocol

Electronics Industries Association EIA

Extended Industry Standard Architecture EISA

ELAN Emulated Local Area Network **EMI** Electromagnetic Interference

Erasable Programmable Read Only Memory **EPROM**

EQL Equalization ER **Explicit Rate** End System, or ES Errored Second

Extended Super Frame

ESF ESI **End System Identifier**

EXZ Excessive Zeroes (Error Event)

FC Face Contact

FCC Federal Communications Commission

Frame Check Sequence **FCS**

FDDI Fiber Distributed Data Interface **FDM** Frequency Division Multiplexing

FEBE Far End Block Error **FEC** Forward Error Correction

Forward Explicit Congestion Notification **FECN**

FFRF Far End Receive Failure **FIFO** First-In. First-Out Frame-Relay Service **FRS FTP** File Transfer Protocol ForeThought PNNI FT-PNNI **FUNI** Frame-Based UNI

GCAC Generic Connection Admission Control

Generic Cell Rate Algorithm GCRA

GFC Generic Flow Control HDB3 High Density Bipolar

High Level Data Link Control **HDLC**

Header Error Control **HEC**

HIPPI High Performance Parallel Interface

HSSI High-Speed Serial Interface

ICMP Internet Control Message Protocol

IDU Interface Data Unit

Institute of Electrical and Electronics Engineers IEEE

Acronyms

IETF Internet Engineering Task Force
ILMI Interim Local Management Interface

IP Internet Protocol

IPX Internetwork Packet Exchange

IS Intermediate system

ISDN Integrated Services Digital Network
ISO International Standards Organization

ITU-T International Telecommunication Union Telecommunication

IWF Interworking Function IXC Interexchange Carriers

JPEG Joint Photographic Experts Group

Kbps Kilobits per second
LAN Local Area Network
LANE LAN Emulation

LAPB Link Access Procedure, Balanced LATA Local Access and Transport Area

LBO Line Build Out

LCV Line Code Violations

LE_ARP LAN Emulation Address Resolution Protocol

LEC LAN Emulation Client

LECS LAN Emulation Configuration Server

LES LAN Emulation Server
LLC Logical Link Control

LOF Loss Of Frame
LOP Loss Of Pointer
LOS Loss Of Signal
LSB Least Significant Bit

MAC Media Access Control
MAN Metropolitan Area Network
MAU Media Attachment Unit
MBS Maximum Burst Size

MCDV Maximum Cell Delay Variance
MCLR Maximum Cell Loss Ratio

MCR Minimum Cell Rate

MCTDMaximum Cell Transfer DelayMIBManagement Information BaseMICMedia Interface Connector

MID Message Identifier

MMFMultimode Fiber Optic CableMPEGMotion Picture Experts GroupMPOAMultiprotocol over ATM

MSB Most Significant Bit

MTU Maximum Transmission Unit

NM **Network Management Entity** NML Network Management Layer NMS Network Management Station

Network-to-Network Interface or Network Node Interface NNI

NPC Network Parameter Control

NRZ Non Return to Zero

Non Return to Zero Inverted NRZI **NSAP** Network Service Access Point National TV Standards Committee NTSC MAO Operation and Maintenance Cell

Optical Carrier level-n OC-n Object Identifier OID Out-of-Frame OOF

OSI Open Systems Interconnection **OSPF** Open Shortest Path First Protocol OUI Organizationally Unique Identifier PAD Packet Assembler Disassembler

PAL Phase Alternate Line **PBX** Private Branch Exchange

PCI Peripheral Component Interconnect

PCM Pulse Code Modulation

Peak Cell Rate PCR Public Data Network PDN PDU Protocol Data Unit PHY Physical Layer

Packet Internet Groper pina

Physical Layer Convergence Protocol **PLCP**

Packet Level Protocol PLP Physical Medium ΡМ

PMD Physical Medium Dependent

Private Network Node Interface or Private Network-to-Network Interface **PNNI**

PPP Point-to-Point Protocol

PROM **Programmable Read-Only Memory**

Primary Reference Source PRS PSN Packet Switched Network

PT Payload Type

Permanent Virtual Circuit (or Channel) **PVC PVCC** Permanent Virtual Channel Connection **PVPC** Permanent Virtual Path Connection

QD Queuing Delay QoS Quality of Service RD **Routing Domain**

Requests For Comment RFCs

Acronyms

RFI Radio Frequency Interference
RIP Routing Information Protocol
RISC Reduced Instruction Set Computer

RTS Request To Send
SA Source Address
SA Source MAC Address
SAP Service Access Point

SAR Segmentation And Reassembly

SC Structured Cabling, or

Structured Connectors, or

Stick and Click

SCR Sustainable Cell Rate

SCSI Small Computer Systems Interface SDLC Synchronous Data Link Control

SDU Service Data Unit

SEAL Simple and Efficient Adaptation Layer
SECAM Systeme En Coleur Avec Memoire

SEL Selector

SES Severely Errored Seconds

SF Super Frame

SGMP Simple Gateway Management Protocol

SIR Sustained Information Rate

SLIP Serial Line IP

SMDS Switched Multimegabit Data Service

SMF Single Mode Fiber

SMTP Simple Mail Transfer Protocol
SNA Systems Network Architecture
SNAP SubNetwork Access Protocol
SNI Subscriber Network Interface

SNMP Simple Network Management Protocol

SONET Synchronous Optical Network

SPANS Simple Protocol for ATM Network Signalling

SPARC Scalable Processor Architecture Reduced instruction set Computer

SPE Synchronous Payload Envelope

SPVC Smart PVC

Signaling System No. 7

SSCOP Service Specific Connection Oriented Protocol

SSCS Service Specific Convergence Sublayer

Straight Tip, or Stick and Turn

Synchronous Transfer Mode

STP Shielded Twisted Pair, Spanning Tree Protocol

STS Synchronous Transport Signal

STM

SVC Switched Virtual Circuit (or Channel)
SVCC Switched Virtual Channel Connection
SVPC Switched Virtual Path Connection

TAXI Transparent Asynchronous Transmitter/Receiver Interface

TC Transmission Convergence
TCP Transmission Control Protocol

TCP/IP Transmission Control Protocol/Internet Protocol

TCR Tagged Cell Rate

TCS Transmission Convergence Sublayer

TDM Time Division Multiplexing

TE Terminal Equipment

TFTP Trivial File Transfer Protocol

TM Traffic Management
UAS Unavailable Seconds
UBR Unspecified Bit Rate
UDP User Datagram Protocol
UNI User-to-Network Interface
UPC Usage Parameter Control

UTOPIA Universal Test & Operations Interface for ATM

UTP Unshielded Twisted Pair

VBR Variable Bit Rate

VC Virtual Channel (or Circuit)
VCC Virtual Channel Connection
VCI Virtual Channel Identifier
VCL Virtual Channel Link
VINES Virtual Network Software
VLAN Virtual Local Area Network

VP Virtual Path

VPC Virtual Path Connection
VPDN Virtual Private Data Network

VPI Virtual Path Identifier
VPL Virtual Path Link

VPN Virtual Private Network VPT Virtual Path Terminator

VS/VD Virtual Source/Virtual Destination

VT Virtual Tributary
WAN Wide-Area Network

ZBTSI Zero Byte Time Slot Interchange

Acronyms

Glossary

10Base-T - a 10 Mbps baseband Ethernet specification utilizing twisted-pair cabling (Category 3, 4, or 5). 10BaseT, which is part of the IEEE 802.3 specification, has a distance limit of approximately 100 meters per segment.

802.1d Spanning Tree Bridging - the IEEE standard for bridging; a MAC layer standard for transparently connecting two or more LANs (often called subnetworks) that are running the same protocols and cabling. This arrangement creates an extended network, in which any two workstations on the linked LANs can share data.

802.3 Ethernet - the IEEE standard for Ethernet; a physical-layer standard that uses the CSMA/CD access method on a bus-topology LAN.

802.5 Token Ring - the IEEE physical-layer standard that uses the token-passing access method on a ring-topology LAN.

AAL Connection - an association established by the AAL between two or more next higher layer entities.

Adapter - A fitting that supplies a passage between two sets of equipment when they cannot be directly interconnected.

Adaptive Differential Pulse Code Modulation (ADPCM) - A technique that allows analog voice signals to be carried on a 32K bps digital channel. Sampling is done at 8Hz with 4 bits used to describe the difference between adjacent samples.

Adaptive Pulse Code Modulation (APCM) - A technique that effectively reduces occupied bandwidth per active speaker by reducing sampling rates during periods of overflow peak traffic.

Address - A unique identity of each network station on a LAN or WAN.

Address Complete Message (ACM) - A B-ISUP call control message from the receiving exchange to sending exchange indicating the completion of address information.

Address Mask - a bit mask used to identify which bits in an address (usually an IP address) are network significant, subnet significant, and host significant portions of the complete address. This mask is also known as the subnet mask because the subnetwork portion of the address can be determined by comparing the binary version of the mask to an IP address in that subnet. The mask holds the same number of bits as the protocol address it references.

Address Prefix - A string of 0 or more bits up to a maximum of 152 bits that is the lead portion of one or more ATM addresses.

Address Resolution - The procedure by which a client associates a LAN destination with the ATM address of another client or the BUS.

Address Resolution Protocol (ARP) - a method used to resolve higher level protocol addressing (such as IP) into the appropriate header data required for ATM; i.e., port, VPI, and VCI; also defines the AAL type to be used.

Agent - a component of network- and desktop-management software, such as SNMP, that gathers information from MIBs.

alarm - an unsolicited message from a device, typically indicating a problem with the system that requires attention.

Alarm Indication Signal (AIS) - In T1, an all ones condition used to alert a receiver that its incoming signal (or frame) has been lost. The loss of signal or frame is detected at the receiving end, and the failed signal is replaced by all the ones condition which the receiver interprets as an AIS. The normal response to this is AIS is for the receiving end to generate a yellow alarm signal as part of its transmission towards the faulty end. (The AIS itself is sometimes called a Blue Signal).

A-Law - The PCM coding and companding standard used in Europe.

Allowable Cell Rate (ACR) - parameter defined by the ATM Forum for ATM traffic management. ACR varies between the MCR and the PCR, and is dynamically controlled using congestion control mechanisms.

Alternate Mark Inversion (AMI) - A line coding format used on T1 facilities that transmits ones by alternate positive and negative pulses.

Alternate Routing - A mechanism that supports the use of a new path after an attempt to set up a connection along a previously selected path fails.

American National Standards Institute (ANSI) - a private organization that coordinates the setting and approval of some U.S. standards. It also represents the United States to the International Standards Organization.

American Standard Code for Information Interchange (ASCII) - a standard character set that (typically) assigns a 7-bit sequence to each letter, number, and selected control characters.

AppleTalk - a networking protocol developed by Apple Computer for communication between Apple's products and other computers. Independent of the network layer, AppleTalk runs on LocalTalk, EtherTalk and TokenTalk.

Application Layer - Layer seven of the ISO reference model; provides the end-user interface.

Application Program (APP) - a complete, self-contained program that performs a specific function directly for the user.

Application Program Interface (API) - a language format that defines how a program can be made to interact with another program, service, or other software; it allows users to develop custom interfaces with FORE products.

Assigned Cell - a cell that provides a service to an upper layer entity or ATM Layer Management entity (ATMM-entity).

asxmon - a FORE program that repeatedly displays the state of the switch and its active ports.

Asynchronous Time Division Multiplexing (ATDM) - a multiplexing technique in which a transmission capability is organized into a priori, unassigned time slots. The time slots are assigned to cells upon request of each application's instantaneous real need.

Asynchronous Transfer Mode (ATM) - a transfer mode in which the information is organized into cells. It is asynchronous in the sense that the recurrence of cells containing information from an individual user is not necessarily periodic.

ATM Adaptation Layer (AAL) - the AAL divides user information into segments suitable for packaging into a series of ATM cells. AAL layer types are used as follows:

- **AAL-1** constant bit rate, time-dependent traffic such as voice and video
- AAL-2 still undefined; a placeholder for variable bit rate video transmission
- **AAL-3/4 -** variable bit rate, delay-tolerant data traffic requiring some sequencing and/or error detection support (originally two AAL types, connection-oriented and connectionless, which have been combined)
- **AAL-5 -** variable bit rate, delay-tolerant, connection-oriented data traffic requiring minimal sequencing or error detection support

ATM Address - Defined in the UNI Specification as 3 formats, each having 20 bytes in length.

ATM Forum - an international non-profit organization formed with the objective of accelerating the use of ATM products and services through a rapid convergence of interoperability specifications. In addition, the Forum promotes industry cooperation and awareness.

ATM Inverse Multiplexing (AIMUX) - A device that allows multiple T1 or E1 communications facilities to be combined into a single broadband facility for the transmission of ATM cells.

ATM Layer link - a section of an ATM Layer connection between two adjacent active ATM Layer entities (ATM-entities).

ATM Link - a virtual path link (VPL) or a virtual channel link (VCL).

ATM Management Interface (AMI) - the user interface to FORE Systems' *ForeThought* switch control software (SCS). AMI lets users monitor and change various operating configurations of FORE Systems switches and network module hardware and software, IP connectivity, and SNMP network management.

ATM Peer-to-Peer Connection - a virtual channel connection (VCC) or a virtual path connection (VPC) directly established, such as workstation-to-workstation. This setup is not commonly used in networks.

ATM Traffic Descriptor - a generic list of parameters that can be used to capture the intrinsic traffic characteristics of a requested ATM connection.

ATM User-to-User Connection - an association established by the ATM Layer to support communication between two or more ATM service users (i.e., between two or more next higher layer entities or between two or more ATM entities). The communication over an ATM Layer connection may be either bidirectional or unidirectional. The same Virtual Channel Identifier (VCI) is used for both directions of a connection at an interface.

atmarp - a FORE program that shows and manipulates ATM ARP entries maintained by the given device driver. This is also used to establish PVC connections.

ATM-attached Host Functional Group (AHFG) - The group of functions performed by an ATM-attached host that is participating in the MPOA service.

atmconfig - a FORE program used to enable or disable SPANS signaling.

atmstat - a FORE program that shows statistics gathered about a given adapter card by the device driver. These statistics include ATM layer and ATM adaptation layer cell and error counts. This can also be used to query other hosts via SNMP.

Attachment User Interface (AUI) - IEEE 802.3 interface between a media attachment unit (MAU) and a network interface card (NIC). The term AUI can also refer to the rear panel port to which an AUI cable might attach.

Auto-logout - a feature that automatically logs out a user if there has been no user interface activity for a specified length of time.

Automatic Protection Switching (APS) - Equipment installed in communications systems to detect circuit failures and automatically switch to redundant, standby equipment.

Available Bit Rate (ABR) - a type of traffic for which the ATM network attempts to meet that traffic's bandwidth requirements. It does not guarantee a specific amount of bandwidth and the end station must retransmit any information that did not reach the far end.

Backbone - the main connectivity device of a distributed system. All systems that have connectivity to the backbone connect to each other, but systems can set up private arrangements with each other to bypass the backbone to improve cost, performance, or security.

Backplane - High-speed communications line to which individual components are connected.

Backward Explicit Congestion Notification (BECN) - A Resource Management cell type generated by the network or the destination, indicating congestion or approaching congestion for traffic flowing in the direction opposite that of the BECN cell.

Bandwidth - usually identifies the capacity or amount of data that can be sent through a given circuit; may be user-specified in a PVC.

Baud - unit of signalling speed, equal to the number of discrete conditions or signal events per second. If each signal event represents only one bit, the baud rate is the same as bps; if each signal event represents more than one bit (such as a dibit), the baud rate is smaller than bps.

Bayonet-Neill-Concelman (BNC) - a bayonet-locking connector used to terminate coaxial cables. BNC is also referred to as Bayonet Network Connector.

Bipolar 8 Zero Substitution (B8ZS) - a technique used to satisfy the ones density requirements of digital T-carrier facilities in the public network while allowing 64 Kbps clear channel data. Strings of eight consecutive zeroes are replaced by an eight-bit code representing two intentional bipolar pulse code violations (000V10V1).

Bipolar Violation (BPV) - an error event on a line in which the normal pattern of alternating high (one) and low (zero) signals is disrupted. A bipolar violation is noted when two high signals occur without an intervening low signal, or vice versa.

B-ISDN Inter-Carrier Interface (B-ICI) - An ATM Forum defined specification for the interface between public ATM networks to support user services across multiple public carriers.

Bit Error Rate (BER) - A measure of transmission quality, generally shown as a negative exponent, (e.g., 10^{-7} which means 1 out of 10^{7} bits [1 out of 10,000,000 bits] are in error).

Bit Interleaved Parity (BIP) - an error-detection technique in which character bit patterns are forced into parity, so that the total number of one bits is always odd or always even. This is accomplished by the addition of a one or zero bit to each byte, as the byte is transmitted; at the other end of the transmission, the receiving device verifies the parity (odd or even) and the accuracy of the transmission.

Bit Robbing - The use of the least significant bit per channel in every sixth frame for signaling.

Bit Stuffing - A process in bit-oriented protocols where a zero is inserted into a string of ones by the sender to prevent the receiver from interpreting valid user data (the string of ones) as control characters (a Flag character for instance).

Border Gateway Protocol (BGP) - used by gateways in an internet connecting autonomous networks. It is derived from experiences learned using the EGP.

bps - bits per second

Bridge - a device that expands a Local Area Network by forwarding frames between data link layers associated with two separate cables, usually carrying a common protocol. Bridges can usually be made to filter certain packets (to forward only certain traffic).

Bridge Protocol Data Unit (BPDU) - A message type used by bridges to exchange management and control information.

Broadband - a service or system requiring transmission channels capable of supporting rates greater than the Integrated Services Digital Network (ISDN) primary rate.

Broadband Access - an ISDN access capable of supporting one or more broadband services.

Broadband Connection Oriented Bearer (BCOB) - Information in the SETUP message that indicates the type of service requested by the calling user.

BCOB-A (Bearer Class A) - Indicated by ATM end user in SETUP message for connection-oriented, constant bit rate service. The network may perform internetworking based on AAL information element (IE).

BCOB-C (Bearer Class C) - Indicated by ATM end user in SETUP message for connection-oriented, variable bit rate service. The network may perform internetworking based on AAL information element (IE).

BCOB-X (Bearer Class X) - Indicated by ATM end user in SETUP message for ATM transport service where AAL, traffic type and timing requirements are transparent to the network.

Broadband Integrated Services Digital Network (B-ISDN) - a common digital network suitable for voice, video, and high-speed data services running at rates beginning at 155 Mbps.

Broadband ISDN User's Part (B-ISUP) - A protocol used to establish, maintain and release broadband switched network connections across an SS7/ATM network.

Broadband Terminal Equipment (B-TE) - An equipment category for B-ISDN which includes terminal adapters and terminals.

Broadcast - Data transmission to all addresses or functions.

Broadcast and Unknown Server (BUS) - in an emulated LAN, the BUS is responsible for accepting broadcast, multicast, and unknown unicast packets from the LECs to the broadcast MAC address (FFFFFFFFFF) via dedicated point-to-point connections, and forwarding the packets to all of the members of the ELAN using a single point-to-multipoint connection.

Brouter (bridging/router) - a device that routes some protocols and bridges others based on configuration information.

Buffer - A data storage medium used to compensate of a difference in rate of data flow or time of occurrence of events when transmitting data from one device to another.

Building Integrated Timing Supply (BITS) - a master timing supply for an entire building, which is a master clock and its ancillary equipment. The BITS supplies DS1 and/or composite clock timing references for synchronization to all other clocks and timing sources in that building.

Bursty Errored Seconds (BES) - a BES contains more than 1 and fewer than 320 path coding violation error events, and no severely errored frame or AIS defects. Controlled slips are not included in determining BESs.

Bursty Second - a second during which there were at least the set number of BES threshold event errors but fewer than the set number of SES threshold event errors.

Byte - A computer-readable group of bits (normally 8 bits in length).

Call - an association between two or more users or between a user and a network entity that is established by the use of network capabilities. This association may have zero or more connections.

Carrier - a company, such as any of the "baby Bell" companies, that provide network communications services, either within a local area or between local areas.

Carrier Group Alarm (CGA) - A service alarm generated by a channel bank when an out-of-frame (OOF) condition exists for some predetermined length of time (generally 300 milliseconds to 2.5 seconds). The alarm causes the calls using a trunk to be dropped and trunk conditioning to be applied.

Carrier Identification Parameter (CIP) - A 3 or 4 digit code in the initial address message identifying the carrier to be used for the connection.

cchan - a FORE program that manages virtual channels on a *ForeRunner* switch running asxd.

Cell - an ATM Layer protocol data unit (PDU). The basic unit of information transported in ATM technology, each 53-byte cell contains a 5-byte header and a 48-byte payload.

Cell Delay Variation (CDV) - a quantification of cell clumping for a connection. The cell clumping CDV (yk) is defined as the difference between a cell's expected reference arrival time (ck) and its actual arrival time (ak). The expected reference arrival time (ck) of cell k of a specific connection is max. T is the reciprocal of the negotiated peak cell rate.

Cell Delineation - the protocol for recognizing the beginning and end of ATM cells within the raw serial bit stream.

Cell Header - ATM Layer protocol control information.

Cell Loss Priority (CLP) - the last bit of byte four in an ATM cell header; indicates the eligibility of the cell for discard by the network under congested conditions. If the bit is set to 1, the cell may be discarded by the network depending on traffic conditions.

Cell Loss Ratio - In a network, cell loss ratio is (1-x/y), where y is the number of cells that arrive in an interval at an ingress of the network; and x is the number of these y cells that leave at the egress of the network element.

Cell Loss Ratio (CLR) - CLR is a negotiated QoS parameter and acceptable values are network specific. The objective is to minimize CLR provided the end-system adapts the traffic to the changing ATM layer transfer characteristics. The Cell Loss Ratio is defined for a connection as: Lost Cells/Total Transmitted Cells. The CLR parameter is the value of CLR that the network agrees to offer as an objective over the lifetime of the connection. It is expressed as an order of magnitude, having a range of 10-1 to 10-15 and unspecified.

Cell Misinsertion Rate (CMR) - the ratio of cells received at an endpoint that were not originally transmitted by the source end in relation to the total number of cells properly transmitted.

Cell Rate Adaptation (CRA) - a function performed by a protocol module in which empty cells (known as unassigned cells) are added to the output stream. This is because there always must be a fixed number of cells in the output direction; when there are not enough cells to transmit, unassigned cells are added to the output data stream.

Cell Relay Service (CRS) - a carrier service which supports the receipt and transmission of ATM cells between end users in compliance with ATM standards and implementation specifications.

Cell Transfer Delay - the transit delay of an ATM cell successfully passed between two designated boundaries. See CTD.

Cell Transfer Delay (CTD) - This is defined as the elapsed time between a cell exit event at the measurement point 1 (e.g., at the source UNI) and the corresponding cell entry event at the measurement point 2 (e.g., the destination UNI) for a particular connection. The cell transfer delay between two measurement points is the sum of the total inter-ATM node transmission delay and the total ATM node processing delay.

Channel - A path or circuit along which information flows.

Channel Associated Signaling (CAS) - a form of circuit state signaling in which the circuit state is indicated by one or more bits of signaling status sent repetitively and associated with that specific circuit.

Channel Bank - A device that multiplexes many slow speed voice or data conversations onto high speed link and controls the flow.

Channel Service Unit (CSU) - An interface for digital leased lines which performs loopback testing and line conditioning.

Channelization - capability of transmitting independent signals together over a cable while still maintaining their separate identity for later separation.

Circuit - A communications link between points.

Circuit Emulation Service (CES) - The ATM Forum circuit emulation service interoperability specification specifies interoperability agreements for supporting Constant Bit Rate (CBR) traffic over ATM networks that comply with the other ATM Forum interoperability agreements. Specifically, this specification supports emulation of existing TDM circuits over ATM networks.

Classical IP (CLIP) - IP over ATM which conforms to RFC 1577.

Clear to Send (CTS) - and RS-232 modem interface control signal (sent from the modem to the DTE on pin 5) which indicates that the attached DTE may begin transmitting; issuance in response to the DTE's RTS.

Clocking - Regularly timed impulses.

Closed User Group - A subgroup of network users that can be its own entity; any member of the subgroup can only communicate with other members of that subgroup.

Coaxial Cable - Coax is a type of electrical communications medium used in the LAN environment. This cable consists of an outer conductor concentric to an inner conductor, separated from each other by insulating material, and covered by some protective outer material. This medium offers large bandwidth, supporting high data rates with high immunity to electrical interference and a low incidence of errors. Coax is subject to distance limitations and is relatively expensive and difficult to install.

Cold Start Trap - an SNMP trap which is sent after a power-cycle (see *trap*).

Collision - Overlapping transmissions that occur when two or more nodes on a LAN attempt to transmit at or about the same time.

Committed Information Rate (CIR) - CIR is the information transfer rate which a network offering Frame Relay Services (FRS) is committed to transfer under normal conditions. The rate is averaged over a minimum increment of time.

Common Channel Signaling (CCS) - A form signaling in which a group of circuits share a signaling channel. Refer to SS7.

Common Management Interface Protocol (CMIP) - An ITU-TSS standard for the message formats and procedures used to exchange management information in order to operate, administer maintain and provision a network.

Concatenation - The connection of transmission channels similar to a chain.

Concentrator - a communications device that offers the ability to concentrate many lower-speed channels into and out of one or more high-speed channels.

Configuration - The phase in which the LE Client discovers the LE Service.

Congestion Management - traffic management feature that helps ensure reasonable service for VBR connections in an ATM network, based on a priority, sustained cell rate (SCR), and peak cell rate (PCR). During times of congestion, bandwidth is reduced to the SCR, based on the priority of the connection.

Connection - the concatenation of ATM Layer links in order to provide an end-to-end information transfer capability to access points.

Connection Admission Control (CAC) - the procedure used to decide if a request for an ATM connection can be accepted based on the attributes of both the requested connection and the existing connections.

Connection Endpoint (CE) - a terminator at one end of a layer connection within a SAP.

Connection Endpoint Identifier (CEI) - an identifier of a CE that can be used to identify the connection at a SAP.

Connectionless Broadband Data Service (CBDS) - A connectionless service similar to Bellcore's SMDS defined by European Telecommunications Standards Institute (ETSI).

Connectionless Service - a type of service in which no pre-determined path or link has been established for transfer of information, supported by AAL 4.

Connectionless Service (CLS) - A service which allows the transfer of information among service subscribers without the need for end-to- end establishment procedures.

Connection-Oriented Service - a type of service in which information always traverses the same pre-established path or link between two points, supported by AAL 3.

Constant Bit Rate (CBR) - a type of traffic that requires a continuous, specific amount of bandwidth over the ATM network (e.g., digital information such as video and digitized voice).

Controlled Slip (CS) - a situation in which one frame's worth of data is either lost or replicated. A controlled slip typically occurs when the sending device and receiving device are not using the same clock.

Convergence Sublayer (CS) - a portion of the AAL. Data is passed first to the CS where it is divided into rational, fixed-length packets or PDUs (Protocol Data Units). For example, AAL 4 processes user data into blocks that are a maximum of 64 kbytes long.

Corresponding Entities - peer entities with a lower layer connection among them.

cpath - a FORE program used to manage virtual paths on a ForeRunner switch running asxd.

cport - a FORE program that monitors and changes the state of ports on a *ForeRunner* switch running asxd.

Cross Connection - a mapping between two channels or paths at a network device.

Customer Premise Equipment (CPE) - equipment that is on the customer side of the point of demarcation, as opposed to equipment that is on a carrier side. See also point of demarcation.

Cut Through - Establishment of a complete path for signaling and/or audio communications.

Cyclic Redundancy Check (CRC) - an error detection scheme in which a number is derived from the data that will be transmitted. By recalculating the CRC at the remote end and comparing it to the value originally transmitted, the receiving node can detect errors.

D3/D4 - Refers to compliance with AT&T TR (Technical Reference) 62411 definitions for coding, supervision, and alarm support. D3/D4 compatibility ensures support of digital PBXes, M24 services, Megacom services, and Mode 3 D3/D4 channel banks at DS-1 level.

D4 Channelization - refers to compliance with AT&T Technical Reference 62411 regarding DS1 frame layout (the sequential assignment of channels and time slot numbers within the DS1).

D4 Framed/Framing Format - in T1, a 193-bit frame format in which the 193rd bit is used for framing and signaling information (the frame/framing bit). To be considered in support of D4 Framing, a device must be able to synchronize and frame-up on the 193rd bit.

Data Communications Equipment (DCE) - a definition in the RS232C standard that describes the functions of the signals and the physical characteristics of an interface for a communication device such as a modem.

Data Country Code (DCC) - This specifies the country in which an address is registered. The codes are given in ISO 3166. The length of this field is two octets. The digits of the data country code are encoded in Binary Coded Decimal (BCD) syntax. The codes will be left justified and padded on the right with the hexadecimal value "F" to fill the two octets.

Data Link - Communications connection used to transmit data from a source to a destination.

Data Link Connection Identifier (DLCI) - connection identifier associated with frame relay packets that serves the same functions as, and translates directly to, the VPI/VCI on an ATM cell.

Data Link Layer - Layer 2 of the OSI model, responsible for encoding data and passing it to the physical medium. The IEEE divides this layer into the LLC (Logical Link Control) and MAC (Media Access Control) sublayers.

Data Set Ready (DSR) - an RS-232 modem interface control signal (sent from the modem to the DTE on pin 6) which indicates that the modem is connected to the telephone circuit. Usually a prerequisite to the DTE issuing RTS.

Data Terminal Equipment (DTE) - generally user devices, such as terminals and computers, that connect to data circuit-terminating equipment. They either generate or receive the data carried by the network.

Data Terminal Ready (DTR) - an RS232 modem interface control signal (sent from the DTE to the modem on pin 20) which indicates that the DTE is ready for data transmission and which requests that the modem be connected to the telephone circuit.

Datagram - a packet of information used in a connectionless network service that is routed to its destination using an address included in the datagram's header.

DECnet - Digital Equipment Corporation's proprietary LAN.

Defense Advanced Research Projects Agency (DARPA) - the US government agency that funded the ARPANET.

Demultiplexing - a function performed by a layer entity that identifies and separates SDUs from a single connection to more than one connection (see *multiplexing*).

Destination End Station (DES) - An ATM termination point which is the destination for ATM messages of a connection and is used as a reference point for ABR services. See SES.

Digital Access and Cross-Connect System (DACS) - Digital switching system for routing T1 lines, and DS-0 portions of lines, among multiple T1 ports.

Digital Cross-connect System (DCS) - an electronic patch panel used to route digital signals in a central office.

Digital Standard n (0, 1, 1C, 2, and 3) (DSn) - a method defining the rate and format of digital hierarchy, with asynchronous data rates defined as follows:

DS0	64kb/s	1 voice channel
DS1	1.544Mb/s	24 DS0s
DS1C	3.152 Mb/s	2 DS1s
DS2	6.312 Mb/s	4 DS1s
DS3	44.736 Mb/s	28 DS1s

Synchronous data rates (SONET) are defined as:

STS-1/OC-1	51.84 Mb/s	28 DS1s or 1 DS3
STS-3/OC-3	155.52 Mb/s	3 STS-1s byte interleaved
STS-3c/OC-3c	155.52 Mb/s	Concatenated, indivisible payload
STS-12/OC-12	622.08 Mb/s	12 STS-1s, 4 STS-3cs, or any mixture
STS-12c/OC-12c	622.08 Mb/s	Concatenated, indivisible payload
STS-48/OC-48	2488.32 Mb/s	48 STS-1s, 16 STS-3cs, or any mixture

DIP (Dual In-line Package) Switch - a device that has two parallel rows of contacts that let the user switch electrical current through a pair of those contacts to on or off. They are used to reconfigure components and peripherals.

Domain Name Server - a computer that converts names to their corresponding Internet numbers. It allows users to telnet or FTP to the name instead of the number.

Domain Naming System (DNS) - the distributed name and address mechanism used in the Internet.

Duplex - Two way communication.

DXI - a generic phrase used in the full names of several protocols, all commonly used to allow a pair of DCE and DTE devices to share the implementation of a particular WAN protocol. The protocols define the packet formats used to transport data between DCE and DTE devices.

DXI Frame Address (DFA) - a connection identifier associated with ATM DXI packets that serves the same functions as, and translates directly to, the VPI/VCI on an ATM cell.

Dynamic Allocation - A technique in which the resources assigned for program execution are determined by criteria applied at the moment of need.

E.164 - A public network addressing standard utilizing up to a maximum of 15 digits. ATM uses E.164 addressing for public network addressing.

E1 - Wide-area digital transmission scheme used predominantly in Europe that carries data at a rate of 2.048 Mbps. E1 lines can be leased for private use from common carriers.

E3 - Wide-area digital transmission scheme used predominantly in Europe that carries data at a rate of 34.368 Mbps. E3 lines can be leased for private use from common carriers.

Edge Device - A physical device which is capable of forwarding packets between legacy interworking interfaces (e.g., Ethernet, Token Ring, etc.) and ATM interfaces based on data-link and network layer information but which does not participate in the running of any network layer routing protocol. An Edge Device obtains forwarding descriptions using the route distribution protocol.

elarp - a FORE program that shows and manipulates MAC and ATM address mappings for LAN Emulation Clients (LECs).

elconfig - a FORE program that shows and modifies LEC configuration. Lets the user set the NSAP address of the LAN Emulation Configuration Server, display the list of Emulated LANs configured in the LECS for this host, display the list of ELANs locally configured along with the membership state of each, and locally administer ELAN membership.

Electrically Erasable Programmable Read Only Memory (EEPROM) - an EPROM that can be cleared with electrical signals rather than the traditional ultraviolet light.

Electromagnetic Interference (EMI) - signals generated and radiated by an electronic device that cause interference with radio communications, among other effects.

Electronics Industries Association (EIA) - a USA trade organization that issues its own standards and contributes to ANSI; developed RS-232. Membership includes USA manufacturers.

Embedded SNMP Agent - an SNMP agent can come in two forms: embedded or proxy. An embedded SNMP agent is integrated into the physical hardware and software of the unit.

Emulated Local Area Network (ELAN) - A logical network initiated by using the mechanisms defined by LAN Emulation. This could include ATM and legacy attached end stations.

End System (ES) - a system where an ATM connection is terminated or initiated (an originating end system initiates the connection).

End System Identifier (ESI) - This identifier distinguishes multiple nodes at the same level in case the lower level peer group is partitioned.

End-to-End Connection - when used in reference to an ATM network, a connection that travels through an ATM network, passing through various ATM devices and with endpoints at the termination of the ATM network.

Enterprise - Terminology generally referring to customers with multiple, non-contiguous geographic locations.

Equalization (EQL) - the process of compensating for line distortions.

Erasable Programmable Read Only Memory (EPROM) - A PROM which may be erased and rewritten to perform new or different functions (normally done with a PROM burner).

Errored Second (ES) - a second during which at least one code violation occurred.

Ethernet - a 10-Mbps, coaxial standard for LANs in which all nodes connect to the cable where they contend for access.

Excessive Zeroes (EXZ) Error Event - An Excessive Zeroes error event for an AMI-coded signal is the occurrence of more than fifteen contiguous zeroes. For a B8ZS coded signal, the defect occurs when more than seven contiguous zeroes are detected.

Explicit Forward Congestion Indication (EFCI) - the second bit of the payload type field in the header of an ATM cell, the EFCI bit indicates network congestion to receiving hosts. On a congested switch, the EFCI bit is set to "1" by the transmitting network module when a certain number of cells have accumulated in the network module's shared memory buffer. When a cell is received that has its EFCI bit set to "1," the receiving host notifies the sending host, which should then reduce its transmission rate.

Explicit Rate (ER) - The Explicit Rate is an RM-cell field used to limit the source ACR to a specific value. It is initially set by the source to a requested rate (such as PCR). It may be subsequently reduced by any network element in the path to a value that the element can sustain. ER is formatted as a rate.

Extended Industry Standard Architecture (EISA) - bus architecture for desktop computers that provides a 32-bit data passage and maintains compatibility with the ISA or AT architecture.

Extended Super Frame (ESF) - a T1 framing format that utilizes the 193rd bit as a framing bit, but whose Superframe is made up of 24 frames instead of 12 as in D4 format. ESF also provides CRC error detection and maintenance data link functions.

Exterior Gateway Protocol (EGP) - used by gateways in an internet, connecting autonomous networks.

Fairness - related to Generic Flow Control, fairness is defined as meeting all of the agreed quality of service requirements by controlling the order of service for all active connections.

Far End Block Error (FEBE) - an error detected by extracting the 4-bit FEBE field from the path status byte (G1). The legal range for the 4-bit field is between 0000 and 1000, representing zero to eight errors. Any other value is interpreted as zero errors.

Far End Receive Failure (FERF) - a line error asserted when a 110 binary pattern is detected in bits 6, 7, 8 of the K2 byte for five consecutive frames. A line FERF is removed when any pattern other than 110 is detected in these bits for five consecutive frames.

Far-End - in a relationship between two devices in a circuit, the far-end device is the one that is remote.

Face Contact (FC) - Designation for fiber optic connector designed by Nippon Telegraph and Telephone which features a movable anti-rotation key allowing good repeatable performance despite numerous mating. Normally referred to as Fiber Connector, FC actually stands for Face Contact and sometimes linked with PC (Point Contact), designated as FC or FC-PC.

FCC Part 68 - The FCC rules regulating the direct connection of non-telephone company provided equipment to the public telephone network.

Federal Communications Commission (FCC) - a board of commissioners appointed by the President under the Communications Act of 1934, with the authority to regulate all interstate telecommunications originating in the United States, including transmission over phone lines.

Fiber Distributed Data Interface (FDDI) - high-speed data network that uses fiber-optic as the physical medium. Operates in similar manner to Ethernet or Token Ring, only faster.

File Transfer Protocol (FTP) - a TCP/IP protocol that lets a user on one computer access, and transfer data to and from, another computer over a network. ftp is usually the name of the program the user invokes to accomplish this task.

First-In, First-Out (FIFO) - method of coordinating the sequential flow of data through a buffer.

Flag - a bit pattern of six binary "1"s bounded by a binary "0" at each end (forms a 0111 1110 or Hex "7E"). It is used to mark the beginning and/or end of a frame.

Flow Control - The way in which information is controlled in a network to prevent loss of data when the receiving buffer is near its capacity.

ForeThought PNNI (FT-PNNI) - a FORE Systems routing and signalling protocol that uses private ATM (NSAP) addresses; a precursor to ATM Forum PNNI (see PNNI).

Forward Error Correction (FEC) - A technique used by a receiver for correcting errors incurred in transmission over a communications channel without requiring retransmission of any information by the transmitter; typically involves a convolution of the transmitted bits and the appending of extra bits by both the receiver and transmitter using a common algorithm.

Forward Explicit Congestion Notification (FECN) - Bit set by a Frame Relay network to inform data terminal equipment (DTE) receiving the frame that congestion was experienced in the path from source to destination. DTE receiving frames with the FECN bit set can request that higher-level protocols take flow control action as appropriate.

Fractional T1 - the use of bandwidth in 64Kbps increments up to 1.544Mbps from a T1 facility.

Frame - a variable length group of data bits with a specific format containing flags at the beginning and end to provide demarcation.

Frame Check Sequence (FCS) - In bit-oriented protocols, a 16-bit field that contains transmission error checking information, usually appended to the end of the frame.

Frame Relay - a fast packet switching protocol based on the LAPD protocol of ISDN that performs routing and transfer with less overhead processing than X.25.

Frame Synchronization Error - an error in which one or more time slot framing bits are in error.

Frame-Based UNI (FUNI) - An ATM switch-based interface which accepts frame-based ATM traffic and converts it into cells.

Frame-Relay Service (FRS) - A connection oriented service that is capable of carrying up to 4096 bytes per frame.

Framing - a protocol that separates incoming bits into identifiable groups so that the receiving multiplexer recognizes the grouping.

Frequency Division Multiplexing (FDM) - a method of dividing an available frequency range into parts with each having enough bandwidth to carry one channel.

Gbps - gigabits per second (billion)

Generic Cell Rate Algorithm (GCRA) - an algorithm which is employed in traffic policing and is part of the user/network service contract. The GCRA is a scheduling algorithm which ensures that cells are marked as conforming when they arrive when expected or later than expected and non-conforming when they arrive sooner than expected.

Generic Connection Admission Control (GCAC) - This is a process to determine if a link has potentially enough resources to support a connection.

Generic Flow Control (GFC) - the first four bits of the first byte in an ATM cell header. Used to control the flow of traffic across the User-to-Network Interface (UNI), and thus into the network. Exact mechanisms for flow control are still under investigation and no explicit definition for this field exists at this time. (This field is used only at the UNI; for NNI-NNI use (between network nodes), these four bits provide additional network address capacity, and are appended to the VPI field.)

GIO - a proprietary bus architecture used in certain Silicon Graphics, Inc. workstations.

Header - protocol control information located at the beginning of a protocol data unit.

Header Error Control (HEC) - a CRC code located in the last byte of an ATM cell header that is used for checking cell header integrity only.

High Density Bipolar (HDB3) - A bipolar coding method that does not allow more than 3 consecutive zeroes.

High Level Data Link Control (HDLC) - An ITU-TSS link layer protocol standard for point-to-point and multi-point communications.

High Performance Parallel Interface (HIPPI) - ANSI standard that extends the computer bus over fairly short distances at speeds of 800 and 1600 Mbps.

High-Speed Serial Interface (HSSI) - a serial communications connection that operates at speeds of up to 1.544 Mbps.

Host - In a network, the primary or controlling computer in a multiple computer installation.

HPUX - the Hewlett-Packard version of UNIX.

Hub - a device that connects several other devices, usually in a star topology.

I/O Module - FORE's interface cards for the LAX-20 LAN Access Switch, designed to connect Ethernet, Token Ring, and FDDI LANs to *ForeRunner* ATM networks.

Institute of Electrical and Electronics Engineers (IEEE) - the world's largest technical professional society. Based in the U.S., the IEEE sponsors technical conferences, symposia & local meetings worldwide, publishes nearly 25% of the world's technical papers in electrical, electronics & computer engineering, provides educational programs for members, and promotes standardization.

IEEE 802 - Standards for the interconnection of LAN computer equipment. Deals with the Data Link Layers of the ISO Reference Model for OSI.

IEEE 802.1 - Defines the high-level network interfaces such as architecture, internetworking and network management.

IEEE 802.2 - Defines the Logical Link Control interface between the Data Link and Network Layers.

IEEE 802.3 - Defines CSMA/CD (Ethernet).

IEEE 802.4 - Defines the token-passing bus.

IEEE 802.5 - Defines the Token Ring access methodology. This standard incorporates IBM's Token Ring specifications.

IEEE 802.6 - Defines Metropolitan Area Networks.

IEEE 802.7 - The broadband technical advisory group.

IEEE 802.8 - The fiber optics technical advisory group.

IEEE 802.9 - Defines integrated data and voice networks.

Integrated Services Digital Network (ISDN) - an emerging technology that is beginning to be offered by the telephone carriers of the world. ISDN combines voice and digital network services into a single medium or wire.

Interexchange Carriers (IXC) - Long-distance communications companies that provide service between Local Access Transport Areas (LATAs).

Interface Data - the unit of information transferred to/from the upper layer in a single interaction across a SAP. Each Interface Data Unit (IDU) controls interface information and may also contain the whole or part of the SDU.

Interface Data Unit (IDU) - The unit of information transferred to/from the upper layer in a single interaction across the SAP. Each IDU contains interface control information and may also contain the whole or part of the SDU.

Interim Local Management Interface (ILMI) - the standard that specifies the use of the Simple Network Management Protocol (SNMP) and an ATM management information base (MIB) to provide network status and configuration information.

Intermediate System (IS) - a system that provides forwarding functions or relaying functions or both for a specific ATM connection. OAM cells may be generated and received.

International Standards Organization (ISO) - a voluntary, non treaty organization founded in 1946 that is responsible for creating international standards in many areas, including computers and communications.

International Telephone and Telegraph Consultative Committee (CCITT) - the international standards body for telecommunications.

Internet - (note the capital "I") the largest internet in the world including large national backbone nets and many regional and local networks worldwide. The Internet uses the TCP/IP suite. Networks with only e-mail connectivity are not considered on the Internet.

internet - while an internet is a network, the term "internet" is usually used to refer to a collection of networks interconnected with routers.

Internet Addresses - the numbers used to identify hosts on an internet network. Internet host numbers are divided into two parts; the first is the network number and the second, or local, part is a host number on that particular network. There are also three classes of networks in the Internet, based on the number of hosts on a given network. Large networks are classified as Class A, having addresses in the range 1-126 and having a maximum of 16,387,064 hosts. Medium networks are classified as Class B, with addresses in the range 128-191 and with a maximum of 64,516 hosts. Small networks are classified as Class C, having addresses in the range 192-254 with a maximum of 254 hosts. Addresses are given as dotted decimal numbers in the following format:

nnn.nnn.nnn.nnn

In a Class A network, the first of the numbers is the network number, the last three numbers are the local host address.

In a Class B network, the first two numbers are the network, the last two are the local host address.

In a Class C network, the first three numbers are the network address, the last number is the local host address.

The following table summarizes the classes and sizes:

Class	First #	Max# Hosts
A	1-126	16,387,064
В	129-191	64,516
С	192-223	254

Glossary

Network mask values are used to identify the network portion and the host portion of the address. Default network masks are as follows:

Class A - 255.0.0.0

Class B - 255.255.0.0

Class C - 255.255.255.0

Subnet masking is used when a portion of the host ID is used to identify a subnetwork. For example, if a portion of a Class B network address is used for a subnetwork, the mask could be set as 255.255.255.0. This would allow the third byte to be used as a subnetwork address. All hosts on the network would still use the IP address to get on the Internet.

Internet Control Message Protocol (ICMP) - the protocol that handles errors and control messages at the IP layer. ICMP is actually a part of the IP protocol layer. It can generate error messages, test packets, and informational messages related to IP.

Internet Engineering Task Force (IETF) - a large, open, international community of network designers, operators, vendors and researchers whose purpose is to coordinate the operation, management and evolution of the Internet to resolve short- and mid-range protocol and architectural issues.

Internet Protocol (IP) - a connectionless, best-effort packet switching protocol that offers a common layer over dissimilar networks.

Internetwork Packet Exchange (IPX) Protocol - a NetWare protocol similar to the Xerox Network Systems (XNS) protocol that provides datagram delivery of messages.

Interoperability - The ability of software and hardware on multiple machines, from multiple vendors, to communicate.

Interworking Function (IWF) - provides a means for two different technologies to interoperate.

IP Address - a unique 32-bit integer used to identify a device in an IP network. You will most commonly see IP addresses written in "dot" notation (e.g., 192.228.32.14).

IP Netmask - a 32-bit pattern that is combined with an IP address to determine which bits of an IP address denote the network number and which denote the host number. Netmasks are useful for sub-dividing IP networks. IP netmasks are written in "dot" notation (e.g., 255.255.0.0).

ISA Bus - a bus standard developed by IBM for expansion cards in the first IBM PC. The original bus supported a data path only 8 bits wide. IBM subsequently developed a 16-bit version for its AT class computers. The 16-bit AT ISA bus supports both 8- and 16-bit cards. The 8-bit bus is commonly called the PC/XT bus, and the 16-bit bus is called the AT bus.

Isochronous - signals carrying embedded timing information or signals that are dependent on uniform timing; usually associated with voice and/or video transmission.

International Telecommunications Union Telecommunications (ITU-T) - an international body of member countries whose task is to define recommendations and standards relating to the international telecommunications industry. The fundamental standards for ATM have been defined and published by the ITU-T (Previously CCITT).

J2 - Wide-area digital transmission scheme used predominantly in Japan that carries data at a rate of 6.312 Mbps.

Jitter - analog communication line distortion caused by variations of a signal from its reference timing position.

Joint Photographic Experts Group (JPEG) - An ISO Standards group that defines how to compress still pictures.

Jumper - a patch cable or wire used to establish a circuit, often temporarily, for testing or diagnostics; also, the devices, shorting blocks, used to connect adjacent exposed pins on a printed circuit board that control the functionality of the card.

Kbps - kilobits per second (thousand)

LAN Access Concentrator - a LAN access device that allows a shared transmission medium to accommodate more data sources than there are channels currently available within the transmission medium.

LAN Emulation Address Resolution Protocol (LE_ARP) - A message issued by a LE client to solicit the ATM address of another function.

LAN Emulation Client (LEC) - the component in an end system that performs data forwarding, address resolution, and other control functions when communicating with other components within an ELAN.

LAN Emulation Configuration Server (LECS) - the LECS is responsible for the initial configuration of LECs. It provides information about available ELANs that a LEC may join, together with the addresses of the LES and BUS associated with each ELAN.

LAN Emulation Server (LES) - the LES implements the control coordination function for an ELAN by registering and resolving MAC addresses to ATM addresses.

LAN Emulation (LANE) - technology that allows an ATM network to function as a LAN backbone. The ATM network must provide multicast and broadcast support, address mapping (MAC-to-ATM), SVC management, and a usable packet format. LANE also defines Ethernet and Token Ring ELANs.

lane - a program that provides control over the execution of the LAN Emulation Server (LES), Broadcast/Unknown Server (BUS), and LAN Emulation Configuration Server (LECS) on the local host.

Latency - The time interval between a network station seeking access to a transmission channel and that access being granted or received.

Layer Entity - an active layer within an element.

Layer Function - a part of the activity of the layer entities.

Layer Service - a capability of a layer and the layers beneath it that is provided to the upper layer entities at the boundary between that layer and the next higher layer.

Layer User Data - the information transferred between corresponding entities on behalf of the upper layer or layer management entities for which they are providing services.

le - a FORE program that implements both the LAN Emulation Server (LES) and the Broadcast/Unknown Server (BUS).

Leaky Bucket - informal cell policing term for the Generic Cell Rate Algorithm which in effect receives cells into a bucket and leaks them out at the specified or contracted rate (i.e., PCR).

Least Significant Bit (LSB) - lowest order bit in the binary representation of a numerical value.

lecs - a FORE program that implements the assignment of individual LECs to different emulated LANs.

leq - a FORE program that provides information about an ELAN. This information is obtained from the LES, and includes MAC addresses registered on the ELAN together with their corresponding ATM addresses.

Line Build Out (LBO) - Because T1 circuits require the last span to lose 15-22.5 dB, a selectable output attenuation is generally required of DTE equipment (typical selections include 0.0, 7.5 and 15 dB of loss at 772 KHz).

Line Code Violations (LCV) - Error Event. A Line Coding Violation (LCV) is the occurrence of either a Bipolar Violation (BPV) or Excessive Zeroes (EXZ) Error Event.

Link - An entity that defines a topological relationship (including available transport capacity) between two nodes in different subnetworks. Multiple links may exist between a pair of subnetworks. Synonymous with logical link.

Link Access Procedure, **Balanced (LAPB) -** Data link protocol in the X.25 protocol stack. LAPB is a bit-oriented protocol derived from HDLC. See also HDLC and X.25.

Link Down Trap - an SNMP trap, sent when an interface changes from a normal state to an error state, or is disconnected.

Link Layer - layer in the OSI model regarding transmission of data between network nodes.

Link Up Trap - an SNMP trap, sent when an interface changes from an error condition to a normal state.

Load Sharing - Two or more computers in a system that share the load during peak hours. During periods of non peak hours, one computer can manage the entire load with the other acting as a backup.

Local Access and Transport Area (LATA) - Geographic boundaries of the local telephone network, specified by the FCC, in which a single LEC may perform its operations. Communications outside or between LATAs are provided by IXCs.

Local Area Network (LAN) - a data network intended to serve an area of only a few square kilometers or less. Because the network is known to cover only a small area, optimizations can be made in the network signal protocols that permit higher data rates.

Logical Link Control (LLC) - protocol developed by the IEEE 802 committee for data-link-layer transmission control; the upper sublayer of the IEEE Layer 2 (OSI) protocol that complements the MAC protocol; IEEE standard 802.2; includes end-system addressing and error checking.

Loopback - a troubleshooting technique that returns a transmitted signal to its source so that the signal can be analyzed for errors. Typically, a loopback is set at various points in a line until the section of the line that is causing the problem is discovered.

looptest - program that tests an interface for basic cell reception and transmission functionality, usually used for diagnostic purposes to determine if an interface is functioning properly.

Loss Of Frame (LOF) - a type of transmission error that may occur in wide-area carrier lines.

Loss Of Pointer (LOP) - a type of transmission error that may occur in wide-area carrier lines.

Loss Of Signal (LOS) - a type of transmission error that may occur in wide-area carrier lines, or a condition declared when the DTE senses a loss of a DS1 signal from the CPE for more the 150 milliseconds (the DTE generally responds with an all ones "Blue or AIS" signal).

Management Information Base (MIB) - the set of parameters that an SNMP management station can query or set in the SNMP agent of a networked device (e.g., router).

Maximum Burst Size (MBS) - the Burst Tolerance (BT) is conveyed through the MBS which is coded as a number of cells. The BT together with the SCR and the GCRA determine the MBS that may be transmitted at the peak rate and still be in conformance with the GCRA.

Maximum Burst Tolerance - the largest burst of data that a network device is guaranteed to handle without discarding cells or packets. Bursts of data larger than the maximum burst size may be subject to discard.

Maximum Cell Delay Variance (MCDV) - This is the maximum two-point CDV objective across a link or node for the specified service category.

Maximum Cell Loss Ratio (MCLR) - This is the maximum ratio of the number of cells that do not make it across the link or node to the total number of cells arriving at the link or node.

Maximum Cell Transfer Delay (MCTD) - This is the sum of the fixed delay component across the link or node and MCDV.

Maximum Transmission Unit (MTU) - the largest unit of data that can be sent over a type of physical medium.

Mbps - megabits per second (million)

Media Access Control (MAC) - a media-specific access control protocol within IEEE 802 specifications; currently includes variations for Token Ring, token bus, and CSMA/CD; the lower sublayer of the IEEE's link layer (OSI), which complements the Logical Link Control (LLC).

Media Attachment Unit (MAU) - device used in Ethernet and IEEE 802.3 networks that provides the interface between the AUI port of a station and the common medium of the Ethernet. The MAU, which can be built into a station or can be a separate device, performs physical layer functions including conversion of the digital data from the Ethernet interface, collision detection, and injection of bits onto the network.

Media Interface Connector (MIC) - fiber optic connector that joins fiber to the FDDI controller.

Message Identifier (MID) - message identifier used to associate ATM cells that carry segments from the same higher layer packet.

Metasignalling - an ATM Layer Management (LM) process that manages different types of signalling and possibly semipermanent virtual channels (VCs), including the assignment, removal, and checking of VCs.

Metasignalling VCs - the standardized VCs that convey metasignalling information across a User-to-Network Interface (UNI).

Metropolitan Area Network (MAN) - network designed to carry data over an area larger than a campus such as an entire city and its outlying area.

MicroChannel - a proprietary 16- or 32-bit bus developed by IBM for its PS/2 computers' internal expansion cards; also offered by others.

Minimum Cell Rate (MCR) - parameter defined by the ATM Forum for ATM traffic management, defined only for ABR transmissions and specifying the minimum value for the ACR.

Most Significant Bit (MSB) - highest order bit in the binary representation of a numerical value.

Motion Picture Experts Group (MPEG) - ISO group dealing with video and audio compression techniques and mechanisms for multiplexing and synchronizing various media streams.

MPOA Client - A device which implements the client side of one or more of the MPOA protocols, (i.e., is a SCP client and/or an RDP client. An MPOA Client is either an Edge Device Functional Group (EDFG) or a Host Behavior Functional Group (HBFG).

MPOA Server - An MPOA Server is any one of an ICFG or RSFG.

MPOA Service Area - The collection of server functions and their clients. A collection of physical devices consisting of an MPOA server plus the set of clients served by that server.

MPOA Target - A set of protocol address, path attributes, (e.g., internetwork layer QoS, other information derivable from received packet) describing the intended destination and its path attributes that MPOA devices may use as lookup keys.

Mu-Law - The PCM coding and companding standard used in Japan and North America.

Multicasting - The ability to broadcast messages to one node or a select group of nodes.

Multi-homed - a device having both an ATM and another network connection, like Ethernet.

Multimode Fiber Optic Cable (MMF) - fiber optic cable in which the signal or light propagates in multiple modes or paths. Since these paths may have varying lengths, a transmitted pulse of light may be received at different times and smeared to the point that pulses may interfere with surrounding pulses. This may cause the signal to be difficult or impossible to receive. This pulse dispersion sometimes limits the distance over which a MMF link can operate.

Multiplexing - a function within a layer that interleaves the information from multiple connections into one connection (see demultiplexing).

Multipoint Access - user access in which more than one terminal equipment (TE) is supported by a single network termination.

Multipoint-to-Multipoint Connection - a collection of associated ATM VC or VP links, and their associated endpoint nodes, with the following properties:

- 1. All N nodes in the connection, called Endpoints, serve as a Root Node in a Point-to-Multipoint connection to all of the (N-1) remaining endpoints.
- 2. Each of the endpoints can send information directly to any other endpoint, but the receiving endpoint cannot distinguish which of the endpoints is sending information without additional (e.g., higher layer) information.

Multipoint-to-Point Connection - a Point-to-Multipoint Connection may have zero bandwidth from the Root Node to the Leaf Nodes, and non-zero return bandwidth from the Leaf Nodes to the Root Node. Such a connection is also known as a Multipoint-to-Point Connection.

Multiprotocol over ATM (MPOA) - An effort taking place in the ATM Forum to standardize protocols for the purpose of running multiple network layer protocols over ATM.

Narrowband Channel - sub-voicegrade channel with a speed range of 100 to 200 bps.

National TV Standards Committee (NTSC) - Started in the US in 1953 from a specification laid down by the National Television Standards Committee. It takes the B-Y and R-Y color difference signals, attenuates them to I and Q, then modulates them using double-sideband suppressed subcarrier at 3.58MHz. The carrier reference is sent to the receiver as a burst during the back porch. An industry group that defines how television signals are encoded and transmitted in the US. (See also PAL, SECAM for non-U.S. countries).

Near-End - in a relationship between two devices in a circuit, the near-end device is the one that is local.

Network Layer - Layer three In the OSI model, the layer that is responsible for routing data across the network.

Network Management Entity (NM) - body of software in a switching system that provides the ability to manage the PNNI protocol. NM interacts with the PNNI protocol through the MIB.

Network Management Layer (NML) - an abstraction of the functions provided by systems which manage network elements on a collective basis, providing end-to-end network monitoring.

Network Management Station (NMS) - system responsible for managing a network or portion of a network by talking to network management agents, which reside in the managed nodes.

Network Module - ATM port interface cards which may be individually added to or removed from any *ForeRunner* ATM switch to provide a diverse choice of connection alternatives.

Network Parameter Control (NPC) - Defined as the set of actions taken by the network to monitor and control traffic from the NNI. Its main purpose is to protect network resources from malicious as well as unintentional misbehavior which can affect the QoS of other already established connections by detecting violations of negotiated parameters and taking appropriate actions. Refer to UPC.

Network Redundancy - Duplicated network equipment and/or data which can provide a backup in case of network failures.

Network Service Access Point (NSAP) - OSI generic standard for a network address consisting of 20 octets. ATM has specified E.164 for public network addressing and the NSAP address structure for private network addresses.

Network-to-Network Interface or Network Node Interface (NNI) - the interface between two public network pieces of equipment.

Node - A computer or other device when considered as part of a network.

Non Return to Zero (NRZ) - a binary encoding scheme in which ones and zeroes are represented by opposite and alternating high and low voltages and where there is no return to a zero (reference) voltage between encoded bits.

Non Return to Zero Inverted (NRZI) - A binary encoding scheme that inverts the signal on a "1" and leaves the signal unchanged for a "0". (Also called transition encoding.)

Nonvolatile Storage - Memory storage that does not lose its contents when power is turned off.

NuBus - a high-speed bus used in Macintosh computers, structured so users can put a card into any slot on the board without creating conflict over the priority between those cards.

nx64K - This refers to a circuit bandwidth or speed provided by the aggregation of nx64 kbps channels (where n= integer > 1). The 64K or DS0 channel is the basic rate provided by the T Carrier systems.

Nyquist Theorem - In communications theory, a formula stating that two samples per cycle is sufficient to characterize a bandwidth limited analog signal; in other words, the sampling rate must be twice the highest frequency component of the signal (i.e., sample 4 KHz analog voice channels 8000 times per second).

Object Identifier (OID) - the address of a MIB variable.

Octet - a grouping of 8 bits; similar, but not identical to, a byte.

One's Density - The requirement for digital transmission lines in the public switched telephone network that eight consecutive "0"s cannot be in a digital data stream; exists because repeaters and clocking devices within the network will lose timing after receiving eight "0"s in a row; a number of techniques are used to insert a "1" after every seventh-consecutive "0" (see Bit Stuffing).

Open Shortest Path First (OSPF) Protocol - a routing algorithm for IP that incorporates least-cost, equal-cost, and load balancing.

Open Systems Interconnection (OSI) - the 7-layer suite of protocols designed by ISO committees to be the international standard computer network architecture.

OpenView - Hewlett-Packard's network management software.

Operation and Maintenance (OAM) Cell - a cell that contains ATM LM information. It does not form part of the upper layer information transfer.

Optical Carrier level-n (OC-n) - The optical counterpart of STS-n (the basic rate of 51.84 Mbps on which SONET is based is referred to as OC-1 or STS-1).

Organizationally Unique Identifier (OUI) - Part of RFC 1483. A three-octet field in the SubNetwork Attachment Point (SNAP) header, identifying an organization which administers the meaning of the following two octet Protocol Identifier (PID) field in the SNAP header. Together they identify a distinct routed or bridged protocol.

Out-of-Band Management - refers to switch configuration via the serial port or over Ethernet, not ATM.

Out-of-Frame (OOF) - a signal condition and alarm in which some or all framing bits are lost.

Packet - An arbitrary collection of data grouped and transmitted with its user identification over a shared facility.

Packet Assembler Disassembler (PAD) - interface device that buffers data sent to/from character mode devices, and assembles and disassembles the packets needed for X.25 operation.

Packet Internet Groper (ping) - a program used to test reachability of destinations by sending them an ICMP echo request and waiting for a reply.

Packet Level Protocol (PLP) - Network layer protocol in the X.25 protocol stack. Sometimes called X.25 Level 3 or X.25 Protocol.

Packet Switched Network (PSN) - a network designed to carry data in the form of packets. The packet and its format is internal to that network.

Packet Switching - a communications paradigm in which packets (messages) are individually routed between hosts with no previously established communications path.

Payload Scrambling - a technique that eliminates certain bit patterns that may occur within an ATM cell payload that could be misinterpreted by certain sensitive transmission equipment as an alarm condition.

Payload Type (PT) - bits 2...4 in the fourth byte of an ATM cell header. The PT indicates the type of information carried by the cell. At this time, values 0...3 are used to identify various types of user data, values 4 and 5 indicate management information, and values 6 and 7 are reserved for future use.

Peak Cell Rate - at the PHY Layer SAP of a point-to-point VCC, the Peak Cell Rate is the inverse of the minimum inter-arrival time T0 of the request to send an ATM-SDU.

Peak Cell Rate (PCR) - parameter defined by the ATM Forum for ATM traffic management. In CBR transmissions, PCR determines how often data samples are sent. In ABR transmissions, PCR determines the maximum value of the ACR.

Peer Entities - entities within the same layer.

Peripheral Component Interconnect (PCI) - a local-bus standard created by Intel.

Permanent Virtual Channel Connection (PVCC) - A Virtual Channel Connection (VCC) is an ATM connection where switching is performed on the VPI/VCI fields of each cell. A Permanent VCC is one which is provisioned through some network management function and left up indefinitely.

Permanent Virtual Circuit (or Channel) (PVC) - a circuit or channel through an ATM network provisioned by a carrier between two endpoints; used for dedicated long-term information transport between locations.

Permanent Virtual Path Connection (PVPC) - A Virtual Path Connection (VPC) is an ATM connection where switching is performed on the VPI field only of each cell. A PVPC is one which is provisioned through some network management function and left up indefinitely.

Phase Alternate Line (PAL) - Largely a German/British development in the late 60s, used in the UK and much of Europe. The B-Y and R-Y signals are weighted to U and V, then modulated onto a double-sideband suppressed subcarrier at 4.43MHz. The V (R-Y) signal's phase is turned through 180 degrees on each alternate line. This gets rid of NTSC's hue changes with phase errors at the expense of de-saturation. The carrier reference is sent as a burst in the back porch. The phase of the burst is alternated every line to convey the phase switching of the V signal. The burst's average phase is -V. (see NTSC for U.S.).

Physical Layer (PHY) - the actual cards, wires, and/or fiber-optic cabling used to connect computers, routers, and switches.

Physical Layer Connection - an association established by the PHY between two or more ATM-entities. A PHY connection consists of the concatenation of PHY links in order to provide an end-to-end transfer capability to PHY SAPs.

Physical Layer Convergence Protocol (PLCP) - a framing protocol that runs on top of the T1 or E1 framing protocol.

Physical Medium (PM) - Refers to the actual physical interfaces. Several interfaces are defined including STS-1, STS-3c, STS-12c, STM-1, STM-4, DS1, E1, DS2, E3, DS3, E4, FDDI-based, Fiber Channel-based, and STP. These range in speeds from 1.544Mbps through 622.08 Mbps.

Physical Medium Dependent (PMD) - a sublayer concerned with the bit transfer between two network nodes. It deals with wave shapes, timing recovery, line coding, and electro-optic conversions for fiber based links.

Plesiochronous - two signals are plesiochronous if their corresponding significant instants occur at nominally the same rate, with variations in rate constrained to specified limits.

Point of Demarcation - the dividing line between a carrier and the customer premise that is governed by strict standards that define the characteristics of the equipment on each side of the demarcation. Equipment on one side of the point of demarcation is the responsibility of the customer. Equipment on the other side of the point of demarcation is the responsibility of the carrier.

Point-to-Multipoint Connection - a collection of associated ATM VC or VP links, with associated endpoint nodes, with the following properties:

- 1. One ATM link, called the Root Link, serves as the root in a simple tree topology. When the Root node sends information, all of the remaining nodes on the connection, called Leaf nodes, receive copies of the information.
- 2. Each of the Leaf Nodes on the connection can send information directly to the Root Node. The Root Node cannot distinguish which Leaf is sending information without additional (higher layer) information. (See the following note for Phase 1.)
- 3. The Leaf Nodes cannot communicate directly to each other with this connection type.

Note: Phase 1 signalling does not support traffic sent from a Leaf to the Root.

Point-to-Point Connection - a connection with only two endpoints.

Point-to-Point Protocol (PPP) - Provides a method for transmitting packets over serial point-to-point links.

Policing - the function that ensures that a network device does not accept traffic that exceeds the configured bandwidth of a connection.

Port Identifier - The identifier assigned by a logical node to represent the point of attachment of a link to that node.

Presentation Layer - Sixth layer of the OSI model, providing services to the application layer.

Primary Reference Source (PRS) - Equipment that provides a timing signal whose long-term accuracy is maintained at 1×10 -11 or better with verification to universal coordinated time (UTC) and whose timing signal is used as the basis of reference for the control of other clocks within a network.

Primitive - an abstract, implementation-independent interaction between a layer service user and a layer service provider.

Priority - the parameter of ATM connections that determines the order in which they are reduced from the peak cell rate to the sustained cell rate in times of congestion. Connections with lower priority (4 is low, 1 is high) are reduced first.

Private Branch Exchange (PBX) - a private phone system (switch) that connects to the public telephone network and offers in-house connectivity. To reach an outside line, the user must dial a digit like 8 or 9.

Private Network Node Interface or Private Network-to-Network Interface (PNNI) - a protocol that defines the interaction of private ATM switches or groups of private ATM switches

Programmable Read-Only Memory (PROM) - a chip-based information storage area that can be recorded by an operator but erased only through a physical process.

Protocol - a set of rules and formats (semantic and syntactic) that determines the communication behavior of layer entities in the performance of the layer functions.

Protocol Control Information - the information exchanged between corresponding entities using a lower layer connection to coordinate their joint operation.

Protocol Data Unit (PDU) - a unit of data specified in a layer protocol and consisting of protocol control information and layer user data.

Proxy - the process in which one system acts for another system to answer protocol requests.

Proxy Agent - an agent that queries on behalf of the manager, used to monitor objects that are not directly manageable.

Public Data Network (PDN) - a network designed primarily for data transmission and intended for sharing by many users from many organizations.

Pulse Code Modulation (PCM) - a modulation scheme that samples the information signals and transmits a series of coded pulses to represent the data.

Q.2931 - Derived from Q.93B, the narrowband ISDN signalling protocol, an ITU standard describing the signalling protocol to be used by switched virtual circuits on ATM LANs.

Quality of Service (QoS) - Quality of Service is defined on an end-to-end basis in terms of the following attributes of the end-to-end ATM connection:

Cell Loss Ratio

Cell Transfer Delay

Cell Delay Variation

Queuing Delay (QD) - refers to the delay imposed on a cell by its having to be buffered because of unavailability of resources to pass the cell onto the next network function or element. This buffering could be a result of oversubscription of a physical link, or due to a connection of higher priority or tighter service constraints getting the resource of the physical link.

Radio Frequency Interference (RFI) - the unintentional transmission of radio signals. Computer equipment and wiring can both generate and receive RFI.

Real-Time Clock - a clock that maintains the time of day, in contrast to a clock that is used to time the electrical pulses on a circuit.

Red Alarm - In T1, a red alarm is generated for a locally detected failure such as when a condition like OOF exists for 2.5 seconds, causing a CGA, (Carrier Group Alarm).

Reduced Instruction Set Computer (RISC) - a generic name for CPUs that use a simpler instruction set than more traditional designs.

Redundancy - In a data transmission, the fragments of characters and bits that can be eliminated with no loss of information.

Registration - The address registration function is the mechanism by which Clients provide address information to the LAN Emulation Server.

Relaying - a function of a layer by means of which a layer entity receives data from a corresponding entity and transmits it to another corresponding entity.

Request To Send (RTS) - an RS-232 modem interface signal (sent from the DTE to the modem on pin 4) which indicates that the DTE has data to transmit.

Requests For Comment (RFCs) - IETF documents suggesting protocols and policies of the Internet, inviting comments as to the quality and validity of those policies. These comments are collected and analyzed by the IETF in order to finalize Internet standards.

RFC1483 - Multiprotocol Encapsulation over ATM Adaptation Layer 5.

RFC1490 - Multiprotocol Interconnect over Frame Relay.

RFC1577 - Classical IP and ARP over ATM.

RFC1755 - ATM Signaling Support for IP over ATM.

Robbed-Bit Signaling - In T1, refers to the use of the least significant bit of every word of frames 6 and 12 (D4), or 6, 12, 18, and 24 (ESF) for signaling purposes.

Route Server - A physical device that runs one or more network layer routing protocols, and which uses a route query protocol in order to provide network layer routing forwarding descriptions to clients.

Router - a device that forwards traffic between networks or subnetworks based on network layer information.

Routing Domain (RD) - A group of topologically contiguous systems which are running one instance of routing.

Routing Information Protocol (RIP) - a distance vector-based protocol that provides a measure of distance, or hops, from a transmitting workstation to a receiving workstation.

Routing Protocol - A general term indicating a protocol run between routers and/or route servers in order to exchange information used to allow computation of routes. The result of the routing computation will be one or more forwarding descriptions.

SBus - hardware interface for add-in boards in later-version Sun 3 workstations.

Scalable Processor Architecture Reduced instruction set Computer (SPARC) - a powerful workstation similar to a reduced-instruction-set-computing (RISC) workstation.

Segment - a single ATM link or group of interconnected ATM links of an ATM connection.

Segmentation And Reassembly (SAR) - the SAR accepts PDUs from the CS and divides them into very small segments (44 bytes long). If the CS-PDU is less than 44 bytes, it is padded to 44 with zeroes. A two-byte header and trailer are added to this basic segment. The header identifies the message type (beginning, end, continuation, or single) and contains sequence numbering and message identification. The trailer gives the SAR-PDU payload length, exclusive of pad, and contains a CRC check to ensure the SAR-PDU integrity. The result is a 48-byte PDU that fits into the payload field of an ATM cell.

Selector (SEL) - A subfield carried in SETUP message part of ATM endpoint address Domain specific Part (DSP) defined by ISO 10589, not used for ATM network routing, used by ATM end systems only.

Semipermanent Connection - a connection established via a service order or via network management.

Serial Line IP (SLIP) - A protocol used to run IP over serial lines, such as telephone circuits or RS-232 cables, interconnecting two systems.

Service Access Point (SAP) - the point at which an entity of a layer provides services to its LM entity or to an entity of the next higher layer.

Service Data Unit (SDU) - a unit of interface information whose identity is preserved from one end of a layer connection to the other.

Service Specific Connection Oriented Protocol (SSCOP) - an adaptation layer protocol defined in ITU-T Specification: Q.2110.

Service Specific Convergence Sublayer (SSCS) - The portion of the convergence sublayer that is dependent upon the type of traffic that is being converted.

Session Layer - Layer 5 in the OSI model that is responsible for establishing and managing sessions between the application programs running in different nodes.

Severely Errored Seconds (SES) - a second during which more event errors have occurred than the SES threshold (normally 10-3).

Shaping Descriptor - *n* ordered pairs of GCRA parameters (I,L) used to define the negotiated traffic shape of an APP connection. The traffic shape refers to the load-balancing of a network, where load-balancing means configuring data flows to maximize network efficiency.

Shielded Pair - Two insulated wires in a cable wrapped with metallic braid or foil to prevent interference and provide noise free transmission.

Shielded Twisted Pair (STP) - two or more insulated wires, twisted together and then wrapped in a cable with metallic braid or foil to prevent interference and offer noise-free transmissions.

Signaling System No. 7 (SS7) - The SS7 protocol has been specified by ITU-T and is a protocol for interexchange signaling.

Simple and Efficient Adaptation Layer (SEAL) - also called AAL 5, this ATM adaptation layer assumes that higher layer processes will provide error recovery, thereby simplifying the SAR portion of the adaptation layer. Using this AAL type packs all 48 bytes of an ATM cell information field with data. It also assumes that only one message is crossing the UNI at a time. That is, multiple end-users at one location cannot interleave messages on the same VC, but must queue them for sequential transmission.

Simple Gateway Management Protocol (SGMP) - the predecessor to SNMP.

Simple Mail Transfer Protocol (SMTP) - the Internet electronic mail protocol used to transfer electronic mail between hosts.

Simple Network Management Protocol (SNMP) - the Internet standard protocol for managing nodes on an IP network.

Simple Protocol for ATM Network Signalling (SPANS) - FORE Systems' proprietary signalling protocol used for establishing SVCs between FORE Systems equipment.

Single Mode Fiber (SMF) - Fiber optic cable in which the signal or light propagates in a single mode or path. Since all light follows the same path or travels the same distance, a transmitted pulse is not dispersed and does not interfere with adjacent pulses. SMF fibers can support longer distances and are limited mainly by the amount of attenuation. Refer to MMF.

Small Computer Systems Interface (SCSI) - a standard for a controller bus that connects hardware devices to their controllers on a computer bus, typically used in small systems.

Smart PVC (SPVC) - a generic term for any communications medium which is permanently provisioned at the end points, but switched in the middle. In ATM, there are two kinds of SPVCs: smart permanent virtual path connections (SPVPCs) and smart permanent virtual channel connections (SPVCCs).

snmpd - an SMNP agent for a given adapter card.

Source - Part of communications system which transmits information.

Source Address (SA) - The address from which the message or data originated.

Source MAC Address (SA) - A six octet value uniquely identifying an end point and which is sent in an IEEE LAN frame header to indicate source of frame.

Source Traffic Descriptor - a set of traffic parameters belonging to the ATM Traffic Descriptor used during the connection set-up to capture the intrinsic traffic characteristics of the connection requested by the source.

Spanning Tree Protocol - provides loop-free topology in a network environment where there are redundant paths.

Static Route - a route that is entered manually into the routing table.

Statistical Multiplexing - a technique for allowing multiple channels and paths to share the same link, typified by the ability to give the bandwidth of a temporarily idle channel to another channel.

Stick and Click (SC) - Designation for an Optical Connector featuring a 2.5 mm physically contacting ferrule with a push-pull mating design. Commonly referred to as Structured Cabling, Structured Connectors or Stick and Click

Stick and Turn (ST) - A fiber-optic connector designed by AT&T which uses the bayonet style coupling rather than screw-on as the SMA uses. The ST is generally considered the eventual replacement for the SMA type connector.

Store-and-Forward - the technique of receiving a message, storing it until the proper outgoing line is available, then retransmitting it, with no direct connection between incoming and outgoing lines.

Straight Tip (ST) - see Stick and Turn.

Structured Cabling (SC) - see Stick and Click.

Structured Connectors (SC) - see Stick and Click.

Sublayer - a logical subdivision of a layer.

SubNetwork Access Protocol (SNAP) - a specially reserved variant of IEEE 802.2 encoding SNAP indicates to look further into the packet where it will fine a Type field.

Subscriber Network Interface (SNI) - the interface between an SMDS end user's CPE and the network directly serving the end user, supported by either a DS1 or DS3 access arrangement.

Super Frame (SF) - a term used to describe the repeating 12 D4 frame format that composes a standard (non-ESF) T1 service.

Super User - a login ID that allows unlimited access to the full range of a device's functionality, including especially the ability to reconfigure the device and set passwords.

Sustainable Cell Rate (SCR) - ATM Forum parameter defined for traffic management. For VBR connections, SCR determines the long-term average cell rate that can be transmitted.

Sustained Information Rate (SIR) - In ATM this refers to the long-term average data transmission rate across the User-to-Network Interface. In SMDS this refers to the committed information rate (similar to CIR for Frame Relay Service).

Switch - Equipment used to interconnect lines and trunks.

Switched Connection - A connection established via signaling.

Switched Multimegabit Data Service (SMDS) - a high-speed, datagram-based, public data network service expected to be widely used by telephone companies in their data networks.

Switched Virtual Channel Connection (SVCC) - A Switched VCC is one which is established and taken down dynamically through control signaling. A Virtual Channel Connection (VCC) is an ATM connection where switching is performed on the VPI/VCI fields of each cell.

Switched Virtual Circuit (or Channel) (SVC) - a channel established on demand by network signalling, used for information transport between two locations and lasting only for the duration of the transfer; the datacom equivalent of a dialed telephone call.

Switched Virtual Path Connection (SVPC) - a connection which is established and taken down dynamically through control signaling. A Virtual Path Connection (VPC) is an ATM connection where switching is performed on the VPI field only of each cell.

Switching System - A set of one or more systems that act together and appear as a single switch for the purposes of PNNI routing.

 $\textbf{Symmetric Connection -} a \ connection \ with \ the \ same \ bandwidth \ specified \ for \ both \ directions.$

Synchronous - signals that are sourced from the same timing reference and hence are identical in frequency.

Synchronous Data Link Control (SDLC) - IBM's data link protocol used in SNA networks.

Synchronous Optical Network (SONET) - a body of standards that defines all aspects of transporting and managing digital traffic over optical facilities in the public network.

Synchronous Payload Envelope (SPE) - the payload field plus a little overhead of a basic SONET signal.

Synchronous Transfer Mode (STM) - a transport and switching method that depends on information occurring in regular, fixed patterns with respect to a reference such as a frame pattern.

Synchronous Transport Signal (STS) - a SONET electrical signal rate.

Systeme En Coleur Avec Memoire (SECAM) - Sequential and Memory Color Television - Started in France in the late 60s, and used by other countries with a political affiliation. This is. The B-Y and R-Y signals are transmitted on alternate lines modulated on an FM subcarrier. The memory is a one line delay line in the receiver to make both color difference signals available at the same time on all lines. Due to FM, the signal is robust in difficult terrain.

Systems Network Architecture (SNA) - a proprietary networking architecture used by IBM and IBM-compatible mainframe computers.

T1 - a specification for a transmission line. The specification details the input and output characteristics and the bandwidth. T1 lines run at 1.544 Mbps and provide for 24 data channels. In common usage, the term "T1" is used interchangeably with "DS1."

T1 Link - A wideband digital carrier facility used for transmission of digitized voice, digital data, and digitized image traffic. This link is composed of two twisted-wire pairs that can carry 24 digital channels, each operating at 64K bps at the aggregate rate of 1.544M bps, full duplex. Also referred to as DS-1.

T3 - a specification for a transmission line, the equivalent of 28 T1 lines. T3 lines run at 44.736 Mbps. In common usage, the term "T3" is used interchangeably with "DS3."

Tachometer - in *ForeView*, the tachometer shows the level of activity on a given port. The number in the tachometer shows the value of a chosen parameter in percentage, with a colored bar providing a semi-logarithmic representation of that percentage.

Tagged Cell Rate (TCR) - An ABR service parameter, TCR limits the rate at which a source may send out-of-rate forward RM-cells. TCR is a constant fixed at 10 cells/second.

Telephony - The conversion of voices and other sounds into electrical signals which are then transmitted by telecommunications media.

Telnet - a TCP/IP protocol that defines a client/server mechanism for emulating directly-connected terminal connections.

Terminal Equipment (TE) - Terminal equipment represents the endpoint of ATM connection(s) and termination of the various protocols within the connection(s).

Throughput - Measurement of the total useful information processed or communicated by a computer during a specified time period, i.e. packets per second.

Time Division Multiplexing (TDM) - a method of traditional digital multiplexing in which a signal occupies a fixed, repetitive time slot within a higher-rate signal.

Token Ring - a network access method in which the stations circulate a token. Stations with data to send must have the token to transmit their data.

topology - a program that displays the topology of a FORE Systems ATM network. An updated topology can be periodically re-displayed by use of the interval command option.

Traffic - the calls being sent and received over a communications network. Also, the packets that are sent on a data network.

Traffic Management (TM) - The traffic control and congestion control procedures for ATM. ATM layer traffic control refers to the set of actions taken by the network to avoid congestion conditions. ATM layer congestion control refers to the set of actions taken by the network to minimize the intensity, spread and duration of congestion. The following functions form a framework for managing and controlling traffic and congestion in ATM networks and may be used in appropriate combinations:

Connection Admission Control Feedback Control Usage Parameter Control Priority Control Traffic Shaping Network Resource Management Frame Discard ABR Flow Control

Traffic Parameter - A parameter for specifying a particular traffic aspect of a connection.

Trailer - the protocol control information located at the end of a PDU.

Transit Delay - the time difference between the instant at which the first bit of a PDU crosses one designated boundary, and the instant at which the last bit of the same PDU crosses a second designated boundary.

Transmission Control Protocol (TCP) - a specification for software that bundles and unbundles sent and received data into packets, manages the transmission of packets on a network, and checks for errors.

Transmission Control Protocol/Internet Protocol (TCP/IP) - a set of communications protocols that has evolved since the late 1970s, when it was first developed by the Department of Defense. Because programs supporting these protocols are available on so many different computer systems, they have become an excellent way to connect different types of computers over networks.

Transmission Convergence (TC) - generates and receives transmission frames and is responsible for all overhead associated with the transmission frame. The TC sublayer packages cells into the transmission frame.

Transmission Convergence Sublayer (TCS) - This is part of the ATM physical layer that defines how cells will be transmitted by the actual physical layer.

Transparent Asynchronous Transmitter/Receiver Interface (TAXI) - Encoding scheme used for FDDI LANs as well as for ATM; supports speed typical of 100 Mbps over multimode fiber.

Transport Layer - Layer Four of the OSI reference model that is responsible for maintaining reliable end-to-end communications across the network.

trap - a program interrupt mechanism that automatically updates the state of the network to remote network management hosts. The SNMP agent on the switch supports these SNMP traps.

Trivial File Transfer Protocol (TFTP) - Part of IP, a simplified version of FTP that allows files to be transferred from one computer to another over a network.

Twisted Pair - Insulated wire in which pairs are twisted together. Commonly used for telephone connections, and LANs because it is inexpensive.

Unassigned Cells - a generated cell identified by a standardized virtual path identifier (VPI) and virtual channel identifier (VCI) value, which does not carry information from an application using the ATM Layer service.

Unavailable Seconds (UAS) - a measurement of signal quality. Unavailable seconds start accruing when ten consecutive severely errored seconds occur.

UNI 3.0/3.1 - the User-to-Network Interface standard set forth by the ATM Forum that defines how private customer premise equipment interacts with private ATM switches.

Unicasting - The transmit operation of a single PDU by a source interface where the PDU reaches a single destination.

Universal Test & Operations Interface for ATM (UTOPIA) - Refers to an electrical interface between the TC and PMD sublayers of the PHY layer.

Unshielded Twisted Pair (UTP) - a cable that consists of two or more insulated conductors in which each pair of conductors are twisted around each other. There is no external protection and noise resistance comes solely from the twists.

Unspecified Bit Rate (UBR) - a type of traffic that is not considered time-critical (e.g., ARP messages, pure data), allocated whatever bandwidth is available at any given time. UBR traffic is given a "best effort" priority in an ATM network with no guarantee of successful transmission.

Uplink - Represents the connectivity from a border node to an upnode.

Usage Parameter Control (UPC) - mechanism that ensures that traffic on a given connection does not exceed the contracted bandwidth of the connection, responsible for policing or enforcement. UPC is sometimes confused with congestion management (see *congestion management*).

User Datagram Protocol (UDP) - the TCP/IP transaction protocol used for applications such as remote network management and name-service access; this lets users assign a name, such as "RVAX*2,S," to a physical or numbered address.

User-to-Network Interface (UNI) - the physical and electrical demarcation point between the user and the public network service provider.

V.35 - ITU-T standard describing a synchronous, physical layer protocol used for communications between a network access device and a packet network. V.35 is most commonly used in the United States and Europe, and is recommended for speeds up to 48 Kbps.

Variable Bit Rate (VBR) - a type of traffic that, when sent over a network, is tolerant of delays and changes in the amount of bandwidth it is allocated (e.g., data applications).

Virtual Channel (or Circuit) (VC) - a communications path between two nodes identified by label rather than fixed physical path.

Virtual Channel Connection (VCC) - a unidirectional concatenation of VCLs that extends between the points where the ATM service users access the ATM Layer. The points at which the ATM cell payload is passed to, or received from, the users of the ATM Layer (i.e., a higher layer or ATMM-entity) for processing signify the endpoints of a VCC.

Virtual Channel Identifier (VCI) - the address or label of a VC; a value stored in a field in the ATM cell header that identifies an individual virtual channel to which the cell belongs. VCI values may be different for each data link hop of an ATM virtual connection.

Virtual Channel Link (VCL) - a means of unidirectional transport of ATM cells between the point where a VCI value is assigned and the point where that value is translated or removed.

Virtual Channel Switch - a network element that connects VCLs. It terminates VPCs and translates VCI values. The Virtual Channel Switch is directed by Control Plane functions and relays the cells of a VC.

Virtual Connection - an endpoint-to-endpoint connection in an ATM network. A virtual connection can be either a virtual path or a virtual channel.

Virtual Local Area Network (VLAN) - Work stations connected to an intelligent device which provides the capabilities to define LAN membership.

Virtual Network Software (VINES) - Banyan's network operating system based on UNIX and its protocols.

Virtual Path (VP) - a unidirectional logical association or bundle of VCs.

Virtual Path Connection (VPC) - a concatenation of VPLs between virtual path terminators (VPTs). VPCs are unidirectional.

Virtual Path Identifier (VPI) - the address or label of a particular VP; a value stored in a field in the ATM cell header that identifies an individual virtual path to which the cell belongs. A virtual path may comprise multiple virtual channels.

Virtual Path Link (VPL) - a means of unidirectional transport of ATM cells between the point where a VPI value is assigned and the point where that value is translated or removed.

Virtual Path Switch - a network element that connects VPLs, it translates VPI (not VCI) values and is directed by Control Plane functions. The Virtual Path Switch relays the cells of a Virtual Path.

Virtual Path Terminator (VPT) - a system that unbundles the VCs of a VP for independent processing of each VC.

Virtual Private Data Network (VPDN) - a private data communications network built on public switching and transport facilities rather than dedicated leased facilities such as T1s.

Virtual Private Network (VPN) - a private voice communications network built on public switching and transport facilities rather than dedicated leased facilities such as T1s.

Virtual Source/Virtual Destination (VS/VD) - An ABR connection may be divided into two or more separately controlled ABR segments. Each ABR control segment, except the first, is sourced by a virtual source. A virtual source implements the behavior of an ABR source endpoint. Backwards RM-cells received by a virtual source are removed from the connection. Each ABR control segment, except the last, is terminated by a virtual destination. A virtual destination assumes the behavior of an ABR destination endpoint. Forward RM-cells received by a virtual destination are turned around and not forwarded to the next segment of the connection.

Virtual Tributary (VT) - a structure used to carry payloads such as DS1s that run at significantly lower rates than STS-1s.

Warm Start Trap - an SNMP trap which indicates that SNMP alarm messages or agents have been enabled.

Wide-Area Network (WAN) - a network that covers a large geographic area.

Wideband Channel - Communications channel with more capacity (19.2K bps) than the standard capacity of a voice grade line.

X.21 - ITU-T standard for serial communications over synchronous digital lines. The X.21 protocol is used primarily in Europe and Japan.

X.25 - a well-established data switching and transport method that relies on a significant amount of processing to ensure reliable transport over metallic media.

Yellow Alarm - An alarm signal sent back toward the source of a failed signal due to the presence of an AIS (may be used by APS equipment to initiate switching).

Zero Byte Time Slot Interchange (ZBTSI) - A technique used with the T carrier extended superframe format (ESF) in which an area in the ESF frame carries information about the location of all-zero bytes (eight consecutive "0"s) within the data stream.

Zero Code Suppression - The insertion of a "1" bit to prevent the transmission of eight or more consecutive "0" bits. Used primarily with T1 and related digital telephone company facilities, which require a minimum "1's density" in order to keep the individual subchannels of a multiplexed, high speed facility active.

Zero-Bit Insertion - A technique used to achieve transparency in bit-oriented protocols. A zero is inserted into sequences of one bits that cause false flag direction.

Glossary

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